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ABSTRACT

This is a critical account of the introduction of a new science curriculum in New South Wales, Australia. The introduction of the new courses is contrasted with methods used to update science courses in other countries and in other Australian States. Reactions from teachers, students, and the public are reported. Statements by the curriculum designers, and administrators' reactions to criticisms of the courses are also included. Appended are a suggested set of objectives for secondary school science, a report of an International Congress organized by the Interunion Commission on Science Teaching, data from an attitude survey of freshman science students at two universities, and recommendations for syllabus reform from a meeting of science teachers. (EB)

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EDUCATION and ALCHEMY

The Story Of Wyndham Science

A. E. Alexander

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The Story Of Wyndham Science

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Dedication

This book is dedicated to the "guinea-pigs", parents and science teachers of New South Wales, in memory of their enforced sacrifices on the altar of "Science" (with a capital S).

"It seems a shame," the Walrus said,
"To play them such a trick
After we've brought them out so far,
And made them trot so quick!"
The Carpenter said nothing but
"The butter's spread too thick!"

(With acknowledgment to *Alice*.)

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General Foreword

"New South Wales parents are very concerned about the inadequacy of the present science courses".

Russell H. Wilkins, Metropolitan Vice-President, The Federation of Parents and Citizens' Associations of New South Wales.

"Parents with high school children and many other members of the public will be well aware of the controversy concerning science education in New South Wales following the introduction of the Wyndham scheme. With science a compulsory subject for all students in the first four years, this is now a matter directly affecting every parent in the State.

"It is therefore of considerable importance for parents to know just what the Wyndham scheme set out to achieve and how 'Wyndham science' eventuated in practice."

J. Mackay, President, Science Committee of the N.S.W. Teachers' Federation.

Author's Preface

Readers from overseas will react to the story of "Wyndham science" like the early settlers reacted to the platypus—"incredible", "impossible"! Readers from other States will merely shrug their shoulders at another example of New South Wales managing to do things "differently".

If the well-being of students, teachers, professional bodies and industry were not involved, to say nothing of a lot of parents' money, we could all enjoy the story. After all it has certainly assured for the State a place in educational history, as a classic example of how NOT to set about curriculum reform.

Our Minister for Education, Mr. Cutler, seems strangely reluctant to prick this South Seas Bubble, as he could with no more than a stroke of his pen. He has merely to order his Education Department to adopt the "code of ethics" which obtains in Victoria and other States. (This precludes any person associated with the development of syllabuses from having any financial interest in commercial ventures related to his activities in the Education Department.) This code is scarcely avant-garde, and it is incredible that it does not already obtain in N.S.W.

In conclusion, it must be emphasised that for no other subject in the Wyndham Scheme has such a situation arisen. There were teething troubles in many areas but, apart from science, general opinion concerning the Wyndham Scheme appears to be very favourable.

21 May, 1969. A. E. ALEXANDER.

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1. Introduction

"Some had literally never done an experiment themselves". (Report of a university professor on students who had successfully completed 6 years "Science" at High School.)

This is not science fiction, the university professor was not joking, nor was he from an undeveloped country. He was referring to the first intake of science students trained under the "Wyndham scheme" in the State of New South Wales, the most populous State in one of the richest countries in the world.

The "Wyndham scheme"', implemented with much sounding of trumpets in 1962, added an additional year to secondary education in N.S.W., thus bringing the "senior State" up to the standard attained by Victoria in 1944 and by most developed countries half a century earlier. Science became a compulsory subject for all students in the first four years, so that the quality of science education is now a matter which directly affects every parent in the State.

Like most university professors I would have remained largely ignorant of what was going on in the science courses of the "Wyndham scheme" until 1968 (when the first intake of "Wyndham guinea-pigs" entered the universities), but for family reasons. These provided the stimulus, whilst on sabbatical leave in Britain in 1966, for studying the syllabus, text-books and Teachers' Manual put out for the new Higher School Certificate course, which had commenced that year. The syllabus was so impossible and the books so poor that I felt impelled to write to the Press in Sydney,[1] making not only some trenchant criticisms but also some concrete suggestions for improvement. Quite unknown to me at the time many science teachers in N.S.W. had, not surprisingly, come to the same conclusions and had registered strong protests.

During the last year, as the disastrous results of the new high school science courses made even the universities stir themselves, I have been inundated with inquiries from disturbed parents, from puzzled university teachers and from some very disgruntled "guinea-pigs" asking the questions, "What went wrong?" and "Why did it go wrong?"

This little survey attempts to provide answers although, as you will see, official reticence has not made the task an easy one.

To understand the N.S.W. situation it has been necessary to indicate how other States updated their science courses. By this time every State in Australia has gone a long way in modernising its science education, in all cases with the general approval of the teaching pro-

fession, the students and the universities. N.S.W. is thus very much "the odd man out".

Some attempt at assessing the cost to N.S.W. of its "Wyndham science" experiment has also been made. If this stirs parents to action, either directly through their political representatives or indirectly through their various societies, then this effort will have been worth while. Unfortunately, our politicians appear less interested in science education than they are in the relatively trivial Opera House "affair" and the problems of the Opera House will have been solved long before those of science education in N.S.W.

Some indication of the costs of science education *in the senior years only* can be gained from the following figures:
Number of teachers involved — about 1200.
Annual cost in salaries, etc. — about $5,000,000.
Value of capital equipment involved (laboratories, scientific equipment, etc.) — about $25,000,000.
(If *junior* science were added these figures would be more than doubled.)

Readers without high school children or other direct involvement in high school education may well be amused by the contrasting assessment of the senior science courses by the parties most involved. On the one hand we have the science teachers who have taught the courses in the schools. They use phrases like "An old bomb which needs a quick panel-beating job while we wait for the new model", and "The science teachers in this State have been taken for a ride". On the other hand we have the small group who were largely responsible not only for the syllabus but also for the "official" text-books written to illustrate the syllabus. This group, headed by Professor Messel and supported by fellow physicists Professors Butler and George, continues to publish laudatory statements like "an example and model for other countries in the world", and "The Wyndham science scheme .... is one which has received world acclaim". It's too tempting not to say "Alice-in-Wyndhamland"!

Recently these professors were challenged to substantiate their belief in the "educational soundness" of their course in the only way possible—namely by taking charge of a class in an average high school in 1969 and 1970 and giving the course in its entirety. The lessons would be recorded on video-tape so that the science teachers could see how the course should be properly taught. We are looking forward to the professorial efforts, that is, if any of them dare accept the challenge. (To date—none have!)

Although I obviously hold strong views as regards "Wyndham science" I have sought to do justice to its protagonists by reproducing their most relevant articles and by attempting a complete bibliography of everything published in its defence. These references may also assist a future student seeking a novel topic for a Master's Degree in Education.

2. The Wyndham Report

In September, 1953, the Minister for Education in N.S.W. set up a Committee with the following terms of reference:

"1. To survey and to report upon the provision of full-time day education for adolescents in New South Wales.

"2. In particular, to examine the objectives, organisation and content of the courses provided for adolescent pupils in the public schools of the State, regard being paid to the requirements of a good general education and to the desirability of providing a variety of curriculum adequate to meet the varying aptitudes and abilities of the pupils concerned".

The Committee, under the chairmanship of the then Director-General of Education, Dr. H. S. Wyndham, presented its Report[2] to the Minister in October, 1957.

Basically the Committee recommended what is frequently termed the 4 plus 2 system, i.e., a four-year course terminating in the "School Certificate" and taken by all students around the age of 16, followed by an optional two-year course leading to the "Higher School Certificate" at the age of about 18.

In the School Certificate Course both Science and Mathematics were recommended as "core" subjects, i.e., to be taken by all students in all schools.

Concerning "Science" for this course, this is what the Report had to say:

"We have avoided the use of the term 'General Science', again because of the danger of fixed patterns of thinking. Many of the syllabuses of study entitled 'General Science' appear to us to be unsatisfactory because they prove to be selections of work from separate sciences, lacking coherence and any evidence of integrating principles. We do not believe that it is impossible to devise a satisfactory course in General Science; we are convinced that it is more easily talked about than done.

"We consider that the neglect of Biological Science is a significant limitation of the experience of ordinary citizens, and that, whatever the title given to Science in the common curriculum, it should embrace some biological study. Indeed, there are grounds for adopting the view that the work of the early years of the secondary school might well be an extension of the work commenced in the primary school under the heading 'Natural Science'. Here again, however, we do not wish to be too specific, since we are aware that, under the stimulus of

a gifted teacher, pupils in the Science class can be led to see implications and to appreciate relationships throughout the world of science, irrespective of the title given to the course they are following".

Since this survey will be particularly concerned with the senior years of high school it is worth quoting in full the relevant summary:

"Higher School Certificate"

"Pupils who wish to proceed beyond the School Certificate level, including those who aim to matriculate, should remain at school to follow a course or courses leading to the Higher School Certificate Examination. The type and content of this examination should be such as to make it acceptable as a test for university matriculation. The further course of study should be designed to cover two years [pp. 72 and 97-98].

"Authority for the conduct of the Higher School Certificate Examination, including courses of study and the issue of the Certificate, should be vested in a Board of Senior School Studies comprising representatives of the Department of Education, the universities and both Departmental and non-Departmental secondary schools.

"While this stage of schooling should be designed to meet the needs of the most able adolescents between the ages of sixteen and eighteen, the two senior years are not to be regarded merely as preparation for matriculation; they are an integral part of the education of these young people. It follows that provision should be made for school activities which are essential to the education of adolescents but which do not involve preparation for examinations.

"The number of subjects in the curriculum may be less than at present prescribed for the Leaving Certificate Examination, but there should be a balance in the choice of subjects a pupil studies.

"The selective nature of this group of pupils and their greater maturity by the age of eighteen years should make possible the provision of courses which will afford matriculants a better prospect of successfully undertaking the early stages of university study" [pp. 97-98].

Two of these points should be particularly borne in mind when we come to consider how "Wyndham science" finally eventuated. These are "the two senior years are not to be regarded merely as a preparation for matriculation" (i.e., for university entry), and the final phrase "courses which will afford matriculants a better prospect of successfully undertaking the early stages of university study".

3. How Other States Modernised Their Science Courses

As is well known, the past two decades have witnessed a tremendous and world-wide upsurge of interest in science education at the High School level. In the U.S.A., the launching of the first Russian Sputnik undoubtedly provided much of the stimulus: in Britain there appeared to have been several factors at work—teacher dissatisfaction with "old-fashioned" courses, general economic problems and a growing awareness of the need to educate a much wider segment of the community.

In the U.S.A., a number of schemes were initiated with support from the National Science Foundation, resulting in the production of a series of text-books, experimental manuals, films and extremely comprehensive Teachers' Guides, in the major sciences. The first to appear (1960) was in physics, and is usually referred to as P.S.S.C. Physics (from Physical Science Study Committee). Next came chemistry with two rather different schemes, Chem.Study (from Chemical Education Materials Study) (1963) and C.B.A. (Chemical Bond Approach Project) in 1964. The corresponding project in biology, the Biological Sciences Curriculum Study (B.S.C.S.), evolved no less than five biology courses.

In the U.K. the initial schemes were given very substantial support by the Nuffield Foundation, and as a result the whole project is referred to as "The Nuffield Foundation Science Teaching Project" or briefly as "Nuffield Science". Although its origins and its evolution were in some ways different from the American pattern, this project too has produced a whole range of teaching materials in the shape of sample schemes, books for background reading, laboratory investigations, films, apparatus and so on. There is no set course: it is up to the teacher to use as much or as little as he pleases.

From these pioneering efforts it emerges very clearly, and not surprisingly, that any radical rethinking of science education is both expensive and time-consuming. For example, the Nuffield Science Project received some m$3 from the Nuffield Foundation and this is quite apart from assistance received from Local Education Authorities and the schools. To illustrate the time factor, let me quote from one of the official publications:

"The books which embody the chemistry course have been through several stages of revision. The first drafts were tried out in a small number of schools, often by the teachers chiefly responsible for

writing them. A systematic trial in a total of 56 schools followed in the academic year 1964-65, and a final revision of the materials in the light of the experience gathered was carried out in the summer of 1965."

Thus before any new teaching material is put out for general adoption it has been stringently tested and evaluated in a variety of schools over a period of several years.

In view of the twin factors of time and cost it is scarcely surprising that many other countries have availed themselves of the American and British teaching materials as they became available. New Zealand adopted the P.S.S.C. Physics course in 1963, following a trial run in 1962. In Australia, Victoria, after seeing the course of action in New Zealand, and running trials, adopted it generally in 1965. Queensland is adopting it in 1969 after trial runs in the previous year and intensive teacher training. Chem.Study is being used in Tasmania, South Australia and Queensland.[3]

In the case of Chem.Study in Queensland, one school tried it out in 1965, 20 selected schools in 1966, and the whole State adopted it in 1967. From first-hand and published reports it has been warmly received by both teachers and students.

With both physics and chemistry only relatively minor changes were found necessary to adapt the U.S. courses to Australian conditions, and some evaluation of the physics course has already been possible.[4] General reaction from Victoria is very favourable, in agreement with New Zealand experience.

The case of biology will be considered in more detail, since it highlights the difference in approach between N.S.W. and the other States.

In January, 1967, a text-book "Biological Science, The Web of Life", together with students' manuals and Teachers' Guide, was published by the Australian Academy of Science, in whom copyright is vested. These teaching materials, initially developed for use in Victoria and South Australia, subsequently proved so successful* that they were adopted by every State apart from N.S.W.

It is worth quoting in full the foreword to "The Web of Life" written by the Chairman of the Committee for Biological Education, Australian Academy of Science, since this exemplifies not only the modern approach to science education but also the normal procedure adopted in any major reform.

"With each new generation our fund of scientific knowledge increases many-fold; in biology we have in recent years experienced a major revolution, comparable to that of the Darwinian period. Yet the

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* I have been told that the number of students wishing to take biology is proving something of an embarrassment. This shows what a properly evolved modern course, backed up by good teaching aids, can do to generate interest in both students and teachers.

periodic revisions of biology curricula have not kept pace with the progress in biological discovery. In particular, there is a widespread feeling of dissatisfaction with the nature and content of our secondary school biology courses, a feeling which has coincided with a rapid increase in the numbers of students taking the subject. Nowadays it is becoming increasingly important for man to understand his own nature and his own place in the world of other organisms on which he relies so much. Biology is thus taking its rightful place, along with the other sciences and the humanities, as an essential part of Everyman's education—and also as a subject of great professional importance. In order to encourage these trends we need a new and dynamic approach to its teaching in schools.

"Considerations of this kind led the American Institute of Biological Sciences, a group representing some 85,000 biologists, to take active steps in 1959 to develop new methods of teaching biology in secondary schools. The Biological Sciences Curriculum Study was organized, with headquarters on the campus of the University of Colorado, and considerable financial support from the American National Science Foundation. One, but by no means the only, result of the work of this group was the writing of a series of five biology courses designed for the American school student, and incorporating a new emphasis on biology as a process of inquiry into the living world.

"The designing and producing of these courses, with their texts, laboratory manuals, teacher's guides, and supplementary materials, involved a major effort extending over several years, effort which involved most fruitful co-operation between active research workers and practising teachers. Trial materials were tested, revised, and retested in 1,150 American secondary schools in the years 1960-1963. In the past, textbooks on school science have usually been written by one or two people; those prepared by the B.S.C.S. resulted from the work of over 1,000 research biologists and teachers, and 150,000 students.

"To neglect this great experiment when preparing new courses for the Australian student would be foolish in the extreme. Thus a group of university and school teachers in South Australia and Victoria, brought together in 1964 to plan new approaches to biology teaching, asked permission of the Americans to use their materials. Permission was granted without hesitation, on the understanding that the American courses be adapted to suit the needs of the Australian student. This has been done, a task in which we owe a tremendous debt to those in America who laid its foundations.

"Our situation is a different one from that in the United States. Our plants and animals, our climates and soils, are different. American school biology courses are in general designed for the student in the 10th Grade. Australian senior biology courses were required for the 11th and 12th years, the last two years of secondary school. Furthermore the Australian course had to be usable either as a two-year or

a one-year course; American courses are designed only for a one-year course. Therefore, although we have retained the approach and much of the content of the original B.S.C.S. courses, the American materials have been substantially rewritten. In doing this we too have been greatly assisted by research biologists in universities and research institutes, by educationalists, and by practising teachers. We have also followed the American example by testing the materials in selected schools while the course was being written. Our grateful thanks are due to those schools who have been involved in this work, some for three consecutive years.

"The new course is not simply a rewriting of a syllabus and a text-book. It is primarily a new method of teaching science, and the use of this text and its accompanying laboratory manuals therefore requires that teachers be adequately prepared in the new approaches before attempting to use the materials in the classrooms. For this reason class sets of the books are available only to schools whose teachers have participated in an appropriate preparation programme.

"The emphasis of this course is on laboratory and field work designed to give the student direct, personal experience of the living world, and to develop in him the understanding and approaches of the scientist by following his methods and ways of thinking. Student participation is therefore a keynote of the course, and the text-book itself is somewhat secondary to the laboratory work. Nevertheless, we believe that this text is up-to-date and will make interesting reading in its own right.

"The purpose of the new course is not so much to provide information, however, but rather to inspire young people to seek for such information themselves, and to show them how to do this, in the hope that throughout their lives they may maintain and apply a scientist's curiosity to the world of living things. The text-book will show how this has been done in the past, but it is primarily a handbook for the laboratory and classroom work of the present.

"Australia is still a young country, largely reliant on primary industry; our single course is therefore based more on the so-called 'green' version of the American B.S.C.S. than on the other courses. The approach is ecological, but also draws from the materials of the other two original versions, particularly the 'blue' version, with its stress on molecular biology. Many of the illustrations have been taken from Australia itself, and this has involved the generous collaboration not only of the universities but also of the C.S.I.R.O. and Government scientists in all States.

"We are greatly indebted to the Education Departments of Victoria and South Australia, who made staff and facilities available for this work, and to the Australian Academy of Science, the Council of which set up a committee to supervise the project and provided a most generous grant which has made the work possible."

Apart from N.S.W., Victoria appears to be the only State which has produced a science text-book at the senior level. This is a chemistry text (with associated Practical Manual) for the final (Matriculation) year. (In Victoria the Leaving Certificate is taken after one year in senior school, and Matriculation after an additional year.)

This project, even though a relatively modest one, involved the full-time efforts of three experienced teachers for a whole year, together with the aid of a very large number of part-time and supporting staff. It is pertinent to point out that none of the authors receive royalties and the profits are set aside to finance the regular revision of the project.

4. How N.S.W. "Modernised Its Science Courses

In 1961, that is after the Wyndham Report had been pigeonholed for four years, the N.S.W. State Government decided that its major proposals (usually referred to as the Wyndham Scheme) should be put into operation in all High Schools in February, 1962.

It rapidly became obvious that the Education Department had no worked-out plans for the implementation, and that our school educacationalists (private or public) were not prepared to tell the politicians that such a major educational change could not properly be organised, virtually from scratch, in some four months.* The inevitable teething troubles did not of course worry either the politicians or the educational administrators—it was the students and teachers who suffered.

Here in brief is the strange tale of "junior" science, followed by a more detailed account of the "senior" science courses.

Science in the Junior Years

The course for the first four years of high school, leading to the award of the School Certificate, is under the control of the Secondary Schools Board. "Science" is included in all years and is taken by all pupils at one of three levels, Ordinary, Credit and Advanced.

At the start of 1962, teachers were given an interim syllabus for the year. The full science syllabus for the new four-year course was only finalised in September of that year and only reached teachers at the start of the school year in 1963.

To write a syllabus at this level is not particularly difficult—the real problems come when the teacher has to translate that syllabus into a "meaningful experience" for his students. Traditionally (and regrettably still with us) the first step in this translational process is to ask: Where is THE book; the text which deviates as little as possible from the syllabus and which leads inexorably to the educational goal—the examination at the end of the course!

The N.S.W. syllabus could have been covered by the teachers making use of a number of texts, for in this area there is an enormous variety if one cares to look. But to have a variety of books might appear to be wasteful—so where was THE book for the new science course?

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* The inaugural meeting of the Interim Board of Studies was held on 26 September, 1961.

Fortunately the Gods had not been idle. At a large dinner, with the Minister for Education as guest-of-honour, the birth was announced.

"Science for High School Students" was a bonny baby, weighing 4 lbs 8 ozs, a thousand pages in length; all for £3/5/-. In the words of the Minister, "It captures in every detail the spirit of the syllabus". The preface informs us that it was written by a group of some twenty science teachers, assisted by two inspectors from the Education Department, under an editorial panel chaired by Professor H. Messel, Head of the Physics School at Sydney University.

Its conception and delivery were greatly helped by a special grant of £25,000 from a beneficent Labour Government. It was printed by, and only available from, the N.S.W. Government Printer—a procedure which was to draw considerable adverse criticism from the local printing industry and from the book-sellers. The publisher, and holder of the copyright, was the Nuclear Research Foundation (later renamed the Science Foundation for Physics) within the University of Sydney, of which Professor Messel is Director.

It might seem incredible, with a new venture which would affect literally every high school student and a considerable number of teachers, that the Education Department should not have consulted with the Teachers' Federation. However, senior officials of the Federation assure me that this was the case.

No information concerning payment to the writers or to the members of the editorial group which produced the Science Textbook has been disclosed by the University of Sydney, and as regards sales, the University has again made no disclosure, but a press article[5] has indicated that "at least 250,000 copies" of the book were initially involved and it ends as follows:

"Parents who are puzzled by the fact that they appear to be paying double the price* they might have paid for a more or less compulsory text-book can console themselves with the thought that the extra price amounts to an indirect subsidy to the Nuclear Research Foundation. The only question is how much the subsidy actually is. Professor Messel is silent on this point".

Since the first "baby" proved too heavy for children to carry to school it was subsequently made into a twin.

Before very long (in 1966), a new venture—"Abridged Science for High School Students"—appeared, also in two volumes. This production covers the Ordinary level only, and was obtained, according to the Introduction, by deleting all the Credit and Advanced level material from the earlier book.

It is interesting to note that "Abridged Science" also brings a change in copyright, Professor Messel's name appearing for the first

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* According to the article a commercial concern was prepared to produce the book for about half the price.

time. "The Copyright in the whole of this work vests in the University of Sydney on behalf of the Nuclear Research Foundation within the University and in Professor H. Messel".

Also new is the inclusion of the following: "Beyond the Commonwealth of Australia and its Territories the Nuclear Research Foundation within the University of Sydney and Professor H. Messel have assigned to Pergamon Press Limited, Oxford, England, the world-wide distribution of this work and all foreign-language editions of it."

Readers opening one of the Nuclear Research Foundation's high-school science texts will notice that, right at the beginning, all texts contain the phrase: "Prepared under the guidance of the N.S.W. Director-General of Education, Dr. H. S. Wyndham, C.B.E., M.A., Ed.E., Dip.Ed., F.A.C.E., and with the co-operation of the Department of Education".

A little later we find a laudatory foreword written by Dr. Wyndham himself and complete with his photograph.

Everyone in N.S.W., and many in other States as well as overseas, will be well aware of the ballyhoo which has surrounded our junior science course, and THE texts.

The key theme is supposed to be "integrated science", but this is clearly untenable on any normal definition of "integrated", as many people have pointed out. For example, in an article entitled "The Integrated Science Course—A Pipe Dream?", J. R. Prince writes:[6]

"A text book which claims to be 'an integrated four-year course in physics, chemistry, biology and geology based on and covering the science syllabus approved by the N.S.W. Secondary Schools Board', consists of a large number of chapters, each one of which is almost exclusively drawn from only one of the traditional disciplines. Indeed the approach in an early chapter on matter and energy is more solely related to the former traditional ways of teaching chemistry than that adopted by many science teachers before the 'integrated' course came into being".

The problems of "integrated science" are considered further in chapter 11 in connexion with the Varna Conference, but it may be stated here that, as far as I know, there has not yet been developed, in any country, an "integrated" science course which educationalists have pronounced satisfactory.

To put the N.S.W. course and THE texts into their right educational perspective let me give one concrete fact. A number of States (initially Victoria and South Australia, subsequently joined by Tasmania and West Australia) recently approached the Commonwealth Government for a grant for a Junior Secondary Science Curriculum project, having previously examined all the local courses and found nothing worthwhile. The Commonwealth Government set the seal on their assessment by providing $750,000 for this purpose.

Newspaper advertisements of 15/3/69 give some idea of the

organisation and type of staff being sought. "The project is being operated by the Australian Council for Educational Research on behalf of education departments in several States and with the support of the Commonwealth Government".

Why has N.S.W. not joined the other States?

Further evidence suggesting serious shortcomings in the present junior course will be presented later. (Chap. 5.)

Science for the Senior Years

As mentioned earlier the senior course, which leads after two further years study to the Higher School Certificate, is controlled by a Board of Senior School Studies. The Board comprises representatives from the universities, high school principals, teachers' organisations, etc., and has as chairman the Director-General of Education.

When the Wyndham Scheme began operating in 1962, this Board had four clear years to work out its policies and to take the steps necessary to implement them.

In the Rules for the Higher School Certificate, as finally adopted by the Board, candidates must present a minimum of five subjects, the only compulsory subject being English (language and literature combined). The major innovation was the appearance of "Science" as a single subject. "Science" can be taken at one of three levels, First, Second or Third, with the second level available as a "full" (2F) or "short" (2S) course. The number of teaching periods per week, as recommended by the Board, was as follows:
First Level—11, Second Level "Full"—9.
Second Level "Short"—6, Third Level—6.
(A period is normally 40 minutes.)

The First and Second Level courses have a "common core" of physics and chemistry and in addition to the common core each course consists of three "lobes", that is three separate subjects chosen from Chemistry, Physics, Biology, or Geology. (For the 2F Level, the physics and chemistry lobes are compulsory.)

What was the educational basis for the decision to treat "Science" as a single entity in the senior years? It was certainly not evolved, as every worthwhile educational advance so far has been, by the only proven method of trial runs in selected schools. (As one teacher said very bitterly at a recent Science Conference: "We had a trial run all right, a run with all the State in it at once!") Nor was it based on experience from other States or from overseas.

Some months ago, in an attempt to find out the educational basis for the Board's decision, I wrote to Dr. Wyndham (Director-General at the relevant time) and to a member of the Board, but have not yet received a reply!

I suggest therefore that, like some other aspects of "Wyndham

science" we shall meet later, it was "plucked from the air" by some university professor as ignorant of high schools as a high school teacher would be of any professor's specialised research interests. As Dr. van Praagh, of the Nuffield Science Project, said in a recent talk in Sydney: "It is very easy to produce something which sounds marvellous but which is quite unsuitable for real schools and real children". And in "real schools" he would of course have included "real teachers"!

In the absence of any official statement regarding the educational basis for "Science" in the senior years, we must seek indirect evidence.

In 1962 and 1963 a number of interested bodies held discussions concerning science courses for the projected Higher School Certificate. In all cases I believe the initiative came from the organisers themselves rather than from the Education Department or the Board of Senior School Studies. Here is a brief account of their deliberations.

Physics

In November, 1962, a three-day conference on the Teaching of Physics was held at Sydney Grammar School. It was attended by some 140 people from private and public schools, the universities, Institute of Physics and the N.S.W. Education Department. One of the invited speakers was from Victoria, his paper being entitled "Recent Advances in the Teaching of Physics in Victoria—The P.S.S.C. Course".

The published report of papers and discussion[7] makes interesting reading in the light of subsequent events. In it two basic themes stand out very clearly; the very considerable interest in and support for the P.S.S.C. Physics Course, the small dissenting group being mainly members of the Physics School of Sydney University, and the widespread concern over the tardiness of the N.S.W. Education Department with new science courses required under the Wyndham Scheme.

A colleague present at the meeting told me of a delightful (and prescient!) comment from the Victorian speaker, following some suggestions from university people that the P.S.S.C. Physics Course did not take the students far enough* and that N.S.W. should develop its own course. The speaker first quoted from the preface of the physics text: "The P.S.S.C. Physics Course is the work of several hundred people, mainly school and college physics teachers, over a period of four years" and then, as punch line, concluded: "If you think you can do better then you must have delusions of grandeur"!

From the published Report, space limits me to only a few of the more pertinent quotations. Here is Dr. Symonds, of the Institute of Physics, following discussions of the procedures of the Education Department:

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* For example, Professor McCusker of Sydney University is recorded as saying, "From what I've heard I suspect rather strongly that it is not a high enough standard for the people we want." (Ref. 7, p. 90.)

"Dr. Symonds, Institute of Physics: 'I'm very much obliged to Mr. Grout-Smith for having done the work that he did in finding out the information. All I should say is that, like Professor McConnell, I'm utterly appalled by the blank wall that we've met. This attitude, and here I'm afraid I can speak without any regard to either N.S.W. or Victoria, being a South Australian myself, that I have never met such a strange situation as that which exists here in N.S.W., where one cannot find out the total content of any committee. The Institute of Physics has attempted in the last little while to find out who are the members of these committees. We have a member of the syllabus committee on our committee and we find great difficulty in sorting out how it is that these things go through the legalistic processes which Mr. Grout-Smith mentioned. I think the difference that one must take into account here is that there is no attempt being made whatsoever to take any notice of professional teachers, professional physicists or any other professional scientists and I feel very strongly that, unless this situation develops other than it is at the moment, it is about time that the professional body spoke out. In Victoria, on the other hand, I know Professor Street and Professor Caro, I know that they work together with the Education Department to get their work done and I think it is about time it happened in this State too.'

"AT THIS POINT THERE WAS GENERAL ACCLAMATION FROM THE BODY OF THE MEETING."

Later, in the final paper entitled "A synthesis of the opinions expressed during this conference", the same speaker remarked:

"It is obvious that one must give consideration to the P.S.S.C. Course. Most teachers who have read the books are stimulated by its approach. It has definite and strong motivating forces on the student as witnessed by all who have had intimate, as distinct from superficial, contact with it. In evaluation of this course, one cannot deny the impact of its well-tried experiments, its films and its texts".

And later: "I believe that you all will resolve that, at the earliest possible date, a committee of parties involved in Secondary School Physics (both Education Department and Science Teachers) and in University Matriculation requirements must be convened. That from this a working party of experts shall be drawn to assess information and draw up a physics syllabus with due regard to existing courses such as the P.S.S.C. course, other defined courses and any modifications thereof. This working party must recommend to the full committee a course for 5th, 6th year Secondary School which is complete, by the end of 1964. By completion, I state that it shall have recommended text-books, guides to teachers, defined requisite equipment and, if so needed, films. During 1965, it will be essential for teachers to receive induction courses ready for the introduction of the course at the beginning of 1966. By this time all equipment must be available in the schools. Again, conscious planning is essential."

"We do not want to see a repetition of the present crisis where

the junior school science syllabus for next year has not yet gone out to teachers in detail. I recommend to you that a resolution embodying these remarks should be sent to the Director of Secondary Education, the Director-General and the Minister of Education."

The meeting passed a number of resolutions, the one most relevant being:

"Recognizing the need for continuing the teaching of the separate sciences in the senior school, urgent attention be given to the formation of a committee of parties involved in Secondary School senior physics courses to provide specifications for facilities and a syllabus for 1964, due consideration being given to the P.S.S.C. Course and similar courses."

Chemistry

A Conference on "Chemistry and the Higher School Certificate" was held at Sydney Grammar School on 21 June, 1963, the reason for holding it being given as follows:[8]

"Persistent rumours had suggested that a general science subject only was favoured by university opinion.† It had seemed desirable to seek the opinions of all who were interested in the teaching and practice of Chemistry and that the relevant information be made available to those who were responsible for decisions on subject choice. An earlier Conference on Physics (November, 1962) had expressed strong preference for the retention of specialist subjects."

The statement submitted to the Press runs as follows:

"About 100 delegates were present at various times during the Conference. They came from the universities, all types of schools and industry. At the conclusion of the Conference, resolutions were carried in favour of retaining a wide choice of sciences suitable for all abilities of candidates taking the Higher School Certificate. The Secondary teachers were almost unanimously opposed to a single general science subject without the opportunity of specialisation. The committee organising the Conference was commissioned to complete the explanation of the resolution for the information of the Board of Senior School Studies."

In the light of the above reports one is forced to the conclusion that the educational policy adopted by the Board of Senior School Studies, far from being based on any consensus of professional opinion, was in point of fact contrary to the clearly expressed and recorded

† In 1962 the University of Sydney favoured a four-strand senior "science" course for students intending to enter science-based faculties at the university. Physics and chemistry were to be major components, biology and earth sciences minor components, with each component taken by a specialist teacher. At least 14 periods per week was envisaged.
In May, 1969, at a Special Meeting of the Faculty of Science, a motion that Faculty re-affirm its 1962 motion was rejected.

consensus of professional opinion for both physics and chemistry. If this professional advice had been followed, science in N.S.W. would not be in the disarray it is today.

Who over-ruled these professional scientists and on what grounds?

Who decided that it was imperative for N.S.W. to embark upon a new type of senior "Science" course which required new text-books, and that both untried courses and untried text-books should be inflicted, without a single pilot trial, on all the High Schools in the State?

Text-books for the Senior Courses

The policy adopted concerning text-books was clearly stated in an article written by O. A. Guth, Executive Secretary of the Nuclear Research Foundation, University of Sydney, and which appeared in 1965 in the scientific periodical "Nature". This states:[9] "The Education Department has invited Professor Messel to produce follow-on textbooks for the fifth and sixth year science course, which will start next year".

These text-books duly appeared, together with a Teachers' Manual, in the fields of Physics, Chemistry and Biology. (Their scientific merits will be discussed later.)

As regards copyright: "The copyright in the whole of this work vests in the University of Sydney on behalf of the Nuclear Research Foundation within the University of Sydney and in Professor H. Messel."

All texts contain the phrase: "Prepared under the guidance of the N.S.W. Director-General of Education". All texts carry a laudatory preface, signed "Harold Wyndham, Director-General of Education" and including the phrase: "The Department of Education in N.S.W. welcomes the unique contribution of the Nuclear Research Foundation within the University of Sydney to an exciting enterprise."

With such "official" support for the N.R.F. texts, and in view of the rumour (which subsequently proved to be correct) that some of the text-book authors would also be examiners, it was scarcely surprising that all high schools in N.S.W. purchased these texts when the new courses started in 1966. As we shall see, the books came quite literally "hot from the press"!

Teacher Resources

One final general matter concerns the lack of appreciation of what the new "Science" courses would demand in the way of teacher qualifications.

The Preamble to the Science Syllabus makes it clear that the individual teacher was expected to cover all components of the course

that is areas of physics, chemistry, biology and geology. He in fact is to be the "integrator".

For a teacher to feel confident and competent at handling the chemistry component he would certainly need chemistry to third-year university level and there are good reasons for believing the same to hold for the other sciences. *I don't suppose there is a single teacher in the N.S.W. Education Department who formally meets this requirement in three sciences (let alone four!) and probably only a handful in two sciences.* To imply, as does the Education Department survey discussed in chapter 5, that a first-year university level course indicates "at least minimally qualified" is quite unrealistic, but even with this unrealistic standard the survey shows that many of those teaching second-level science do not meet it. (In physics and chemistry the figure is around 10%, in biology and geology around 20%.) A colleague after conducting a retraining course for teachers wrote to me: "In many cases, the level of knowledge alone was appalling and the proposition that these people could properly teach an integrated course across four disciplines close to ridiculous".

How then could educational administrators in the Education Department, knowing full well the number and qualifications of available science teachers, agree to put on a course whose requirements could not even remotely be met?

5. Teacher Reaction

The grand "pilot-run" with the new senior courses (i.e., in all the 400-odd high schools at one fell swoop) commenced operating in January, 1966. The text-books in Physics, Chemistry and Biology, together with a so-called Teachers' Manual, appeared hot from the press in the nick of time and patently unproofed. (In view of their different colours the text-books rapidly acquired their now standard names—the Yellow Peril, the Red Menace and the Green Jungle.)

Teacher reaction came quickly and vehemently, and indeed, in all my thirty-odd years in education, I have never met, or heard of, anything remotely like it! Their criticisms included the structure of the course, the content of the course (the syllabuses) and the "official" Nuclear Research Foundation texts and Teachers' Manual.

Concrete evidence of teachers' views is available from the resolutions of no less than three special conferences, from two surveys and from innumerable published letters and articles.

The first conference was held in August, 1966. This was how one paper reported the proceedings:[10]

"Science Course Too Tough, Say Teachers"

"The senior school science syllabus in N.S.W. should be cut by 60 per cent and the role of university staff in determining the syllabus drastically curtailed, the School Delegates' Conference was told in Sydney yesterday."

"An executive member of the N.S.W. Teachers' Federation told more than 1000 science teachers attending the conference that the senior syllabus had been determined by a majority of self-opinionated academics with narrow interests.

"There was loud applause when he said: 'It's about time they threw Butler and all the other academics out of the syllabus committee.' "

The article then goes on to mention considerable criticism of courses, school arrangements and the N.R.F. texts, particularly the physics text.

At the second conference, held following a further bout of criticisms in the Press in mid-67, the N.S.W. Secondary Teachers' Association passed the following resolution:

"This Conference of High School Science Teachers requests the N.S.W. Director-General of Education to withdraw his personal support of the Nuclear Research Foundation's text books entitled 'Science for High Schools' and 'Senior Science for High School Students'. The

experience of the past two years has shown the books on Physics and Chemistry to be badly written, difficult to understand and unsuitable for secondary students and the Physics book at least contains errors. It is damaging to the reputation of the Education Department to have the Director-General's name associated with the production of books of such inferior quality."

(This resolution might also have mentioned errors in the Chemistry text and in the Teachers' Manual. A recent scan of the second printing of the Chemistry text showed that only two out of sixteen rather obvious errors had been corrected. No attempt at ironing-out obscurities had been made.)

In October, 1968, stimulated by the special meeting of the Faculty of Science at Sydney University referred to in the next chapter, I wrote to a number of newspapers saying quite bluntly that the senior science scheme was clearly disastrous (as experienced teachers had predicted two years earlier) and that something had to be done urgently.[11] The response from individual teachers and teacher organisations was so spontaneous and so obviously deep-felt that I sent the following questionnaire to every high school in N.S.W. teaching senior science:

Dear Teacher,

You have doubtless seen the recent correspondence arising from the problems of this year's intake of science students into the universities.

Many feel that these problems have arisen from an overloaded school syllabus. The attached questionnaire is an attempt to ascertain the views of practising teachers.

Co-operation from you and your colleagues and an early return of the information sought would be appreciated.

All information supplied will be treated as strictly confidential.

A. E. ALEXANDER, University of Sydney.

SCIENCE IN 5th AND 6th YEARS

Suggestions for reducing the existing Second Level (2S and 2F) syllabus within the present time allocation

Since the majority of students are taking Second Level Science it would seem more important to concentrate on this problem initially. Suggestions concerning depth of treatment for those topics which you feel should be retained would be very helpful.

1) Comments on the state of preparation of students entering 5th year (e.g., understanding of specific areas in the theory, competence in specific areas of practical work.)
Would it be desirable to spend some time consolidating the work ostensibly covered in the 4-year course? If so, how many periods should be allowed?

2) Suggestions for specific deletions.
3) Suggestions for topics which should be retained (with number of periods required, if possible).
4) Comments concerning practical work (e.g., was there sufficient time, were suggested experiments suitable?).
5) Any other comments relevant to revision of the present 5th and 6th year syllabus.

The response was most gratifying and information from about one-quarter of all high schools is now available. (The replies have been retyped leaving out any reference to source, and so can be made available to interested people.) One well-known Sydney headmaster returned the questionnaire (unanswered) with a stiff letter pointing out that, by sending it addressed to the Senior Science Master, I had not observed due protocol. Colonialism dies hard!

All those who have studied the replies agree that certain general points stand out and one does not have to be a scientist to appreciate them. This is what one reporter wrote:[12]

"A senior Education Department official last week dismissed this questionnaire as 'unscientific'."

But, unscientific or not, some of the replies the professor has had roundly condemn the course and the text-books.

As one reads through the 100 or so replies, a pattern emerges:

Students are not well enough grounded in first principles in the first four years to undertake more specialised work in the last two.

There is not time for laboratory experiments. And even if there were, some wouldn't work.

Because the examination system is "objective"—allowing students to pick answers from four or five choices—pupils are not reasoning their way to correct answers, but guessing them". Then follow some specific points and quotations. (The failure of our junior science course to provide a sound basis for the senior course would surprise no one who has compared its approach with that used by the Nuffield Science Project in Britain, or by the Junior Science courses being developed conjointly by Victoria and South Australia.)

From all the many very relevant and patently sincere comments from teachers I have, regrettably, only space for a few: I could easily fill a small book!

Each of the following comes from a different teacher, or from a group of teachers:

1. "I would be very happy to serve on any committee or hear more of your project to rectify the serious state of science teaching in this State.

"I have carried out research work into methods of teaching science and in my experience both the syllabus for School Certificate Science

and the syllabus for Higher School Certificate Science are contrary to the formation of scientific method."

2. "The members of the science staff of this school fully support every word of criticism which has appeared in your letters in the *Sydney Morning Herald* recently, concerning the senior science course."

3. "For three years I have struggled to make Higher School Certificate Science a meaningful experience for my students but have to confess failure and frustration in spite of small classes and adequate laboratory space.

"Please include me in your attempt to goad the 'establishment' into saving something from the present wreck of chemistry teaching in this State, even at the expense of some damage to the reputation of certain educationalists."

4. "My comments will be brief as this will be the fourth time that I have written my opinion on the Senior Science Courses. When the first entry was made by Science teachers we were instructed to send our comments to Mr. Barker, Staff Inspector, so I did this. Then he sent a detailed questionnaire for me to fill in, which I did. Then the Secondary Schools Board sent a very detailed questionnaire, and I filled it in. More than 12 months have elapsed and I have heard no results at all of these 'opinion polls'.

"Practising teachers, particularly those from average comprehensive high schools throughout the State, have insufficient say in what we should teach; university professors do not realize that they receive only the cream of our students. The majority of our students are inferior to them and courses should be designed to suit them. They should not be demoted to Third Level Science because they do not intend to study science at the tertiary level. I agree with Dr. van Praagh who recently said that courses should be biased in favour of those who will not be getting any more of the subject when they leave school. At present in N.S.W. too much emphasis is placed on what the universities want them to know by the time they reach university—too bad if this does not suit the majority of students taking the course. In view of the above I feel that the Nuclear Research Foundation (N.R.F.) chemistry text is the driest and least satisfactory text I have used in 14 years of teaching."

5. "Many experiments in the text are most unsuitable and some won't even work."

6. "Practical work as suggested in N.R.F. textbooks is not usually possible—many too difficult, many irrelevant, many don't work."

7. "I am glad of the chance to write on the existing Second Level Science syllabus. I believe the students fare worse in physics than in chemistry and will confine my comments to 2S physics.

"This syllabus (2S physics) is hopelessly overloaded; the teacher has no time for consolidation—he becomes a lecturer under high

pressure. Experimental work is neglected—it must be, if the student is to have a fair chance at the examination. I had thought of writing you a general letter but the whole show is so faulty that complete criticism would fill a book!"

8. "In this school where two science teachers are available for the teaching of 250 students, it is necessary to combine levels in all years.

"To add to this difficulty Levels 1, 2F and 2S have to be combined and as well 5th and 6th Form classes are combined. The 5th and 6th Form Third Level classes are combined in a separate group."

(This is how our present senior science, with all its marvellous sounding "levels" and "lobes", can work out in practice in a country high school in N.S.W.)

And so it went on, with variations but with the same general tone. One teacher, whose feelings evidently got the better of him, wrote: "They have b----d the whole thing up"!

From the whole stack of replies, representing the views of some three hundred science teachers, there was one, but only one, odd man out. He thought everything was marvellous and answered my last question (any other comments relevant to revision of the syllabus) as follows:

"That it be left to people who understand the *AIMS* of modern secondary education meaning, in particular, *not* your good self"!

At the time of sending out my questionnaire I was quite unaware that the Education Department had already tested teacher reaction in a most elaborate (and no doubt very scientific!) questionnaire[13] to which about one-third of all high schools replied (i.e., not many more than replied to mine). Its conclusions were very similar to those reached by my "unscientific" questionnaire and teacher opinion was very obvious. One teacher wrote:

"The present Science courses in N.S.W. are so ill-conceived and the text-books so poor that I have decided to stop teaching science completely and teach mathematics instead. Little notice has been taken of the opinions of experienced qualified teachers when it really mattered and now, as far I am concerned, it is too late to start asking for my opinions. The necessity for your questionnaire is a demonstration of your sorry plight and that of so many students."

That report was presented to the Board of Senior School Studies on 14 December, 1967, so that its basic information would have been available some months earlier. It is not hard to see why the Board did not give it any publicity, nor why it was virtually pigeon-holed.

The third conference of science teachers was held on 7 December, 1968, and was attended by over 400 people. All the major science teachers' organisations in the State, namely the Science Teachers' Association of N.S.W., the Catholic Secondary Schools' Science Association of N.S.W., the N.S.W. Secondary Teachers' Association

and the Science Committee of the Teachers' Federation, were represented by their respective Presidents. This point is emphasised to highlight the shallowness of certain suggestions that criticism comes from a small, unrepresentative group of science teachers (see chapter 11). In addition to the teachers' organisations, many other groups were represented—officially or unofficially—such as the Parents and Citizens' Association, the Institute of Physics, the Royal Australian Chemical Institute, and the universities and technical colleges.

Everyone who attended agreed that it was a most memorable conference—in more ways than one!

After the official opening by the Vice-Chancellor of the University of Sydney we heard four interstate speakers tell us something about recent developments in science education in the States of Victoria, South Australia and Queensland. Their accounts showed up just how amateurish and educationally insignificant has been our development of science education in N.S.W. For example, little South Australia, with one-quarter of N.S.W's. population, can afford "subject consultants"—something quite unheard-of in N.S.W. (A "subject-consultant" is a person freed from all formal teaching duties whose job it is to try out new ideas, keep an eye on developments in other States and overseas, and help teachers in the schools; all this in one area of science, such as physics, chemistry, biology, etc.). We heard of the massive experiment in junior science curriculum development, a joint effort between Victoria and South Australia, for which substantial Commonwealth assistance has been forthcoming. We learned of how, in other States, profits from "official" text-books and teaching aids are ploughed back to further improve science education and that writers of "official" text-books and other teaching aids are expressly precluded from receiving royalties.

After the interstate speakers we moved to the main business of the meeting—discussion of "Senior Science". Five resolutions were passed, the first and main motion reading as follows:

"1. *N.S.W. Senior Secondary Science Syllabus*

"The existing science syllabuses and methods of examining for the N.S.W. Higher School Certificate are unsatisfactory and this Conference demands that new syllabuses be prepared and that improved methods of examining be sought.

"The new syllabuses should be prepared by a full-time paid Syllabus Construction Group, containing a majority of practising teachers, with experience in teaching the present syllabuses, seconded for the purpose for a limited time. This group should also investigate and report on methods of examining.

"The Syllabus Construction Group should operate in association with the Senior Science Syllabus Committee and should commence work at the beginning of the school year, 1969.

"New INTERIM syllabuses should be made ready for introduc-

tion to schools at the beginning of 1970. The Syllabus Construction Group should then proceed to test the interim syllabuses and refine them in the light of experience. No syllabus should be finally adopted until it has been proved by experience to be thoroughly satisfactory. It is envisaged that the total work of the Syllabus Construction Group will take several years to complete and that in view of the rapid developments taking place in the field of science it may be necessary for the Group to continue indefinitely.

"During the preparation of the interim syllabuses and afterwards, the Syllabus Construction Group should release regular progress reports for full public discussion and should regularly seek opinions from teachers and other interested parties. The first duty of the Syllabus Construction Group should be to examine thoroughly current developments in syllabus construction both in Australia and overseas, and then to draw up a clear statement of objectives expressed in behavioural terms to form a basis for further planning." (See Appendix I.)

One of the local papers reported the meeting as follows:[14]

"An old bomb which needs a quick panel-beating job while we wait for the new model, is how the science syllabus conference saw the fifth and sixth-year school science syllabus on Saturday.

"The analogy was introduced by the President of the N.S.W. Science Teachers' Association, Dr. D. J. Carswell, to the 400 school and university science teachers gathered at Sydney Boys' High School.

"And almost all present agreed that a full-time syllabus construction group should prepare an interim syllabus for 1970 and the State Government should co-operate with other States in a 'senior secondary science project' to produce curricula for introduction in four or five years.

"Speakers claimed that the 'old bomb' was hurriedly prepared by a part-time committee containing too many university representatives keen to prepare students for university, and too few practising teachers.

"The 'grossly overloaded' syllabus had been introduced without pilot trials—unless the present 'disaster' was regarded as one huge 'super-trial', they said.

"The Chairman of the N.S.W. Teachers' Federation science committee and principal organiser of the conference, Mr. Jack MacKay, called the 'old bomb' the 'worst syllabus in the history of science education'.

" 'The science teachers in this State have been taken for a ride and it's time to stand up and say so,' he said."

One teacher at the conference made a delightful parody. "Let us," he said, "have a new subject, 'Language', in the senior years. It will have a 'core' of say English, French and German, with 'lobes' of Spanish, Italian, Swedish, Russian, etc. It will be given in six periods per week and it will all be taught by the one teacher!"

(On a more serious note a not unreasonable parallel to "Science" would be "Romance Language", in which French, Italian and Spanish were taught as an "integrated" or "co-ordinated" "subject". No one would deny that the study of any one of these languages would assist the study of the others, nor that, if successful, the "subject" would be helpful to a first-year Arts student at university. But the language experts have not attempted to thrust such a scheme, without trial runs and without suitably trained teachers, upon all schools in the State in one fell swoop; quite apart from trying to do the "subject" in six periods per week!)

The conference passed (also virtually unanimously) three other resolutions, entitled "The Aims and Objectives of Senior Secondary Science", "Curriculum Development" and "Teacher Education" respectively. Of these, the second read:

"That we call on the N.S.W. Government to co-operate with the governments of other States in establishing with Federal financial assistance a Senior Secondary Science Project to develop tested courses and study material for senior secondary students".

The background to this resolution is as follows: The Federal Government has decided that assistance for curriculum development will only be given if two or more States are prepared to collaborate in a joint venture, the Junior Science Project initiated by Victoria and South Australia being a case in point. In the middle of 1968 Victoria approached the N.S.W. Board of Senior School Studies with a view to joining forces in a joint approach to the Federal Government for funds for curriculum development in physics. The official reply was in the negative—and this at a time when the N.S.W. courses had been well and truly hammered!

The conference ended with a resolution concerned with implementation and future plans:

"That the decisions of Conference be conveyed by those present to their organisations, schools and universities, with a view to having representations made to the appropriate authorities. That a second 'Science Syllabus Conference' be held in 1969 no later than June of that year to review the results of the present Conference and to extend, wherever necessary, the recommendations of the present Conference. That the Director-General of Education be invited now to that Conference."

6. Student Reaction

Most of the "feed-back" from students has naturally come from their usual confidants—their teachers and their parents. Quite unique in my experience, however, was the fact that a group of N.S.W. sixth-form students felt impelled to write to the newspapers about the new course. Here is their delightful letter:[15]

"We would like to express our sympathy with Professor Alexander's views on the Higher School Certificate Syllabus. Although we think that lambs being led to a slaughter provides a better analogy to our case than guinea-pigs, we will support the latter analogy by squealing".

In a number of personal talks and private letters, students have been even more scathing about the course and the N.R.F. text-books.

An interesting and very revealing study of student attitudes to their high school "Science" has recently been carried out by Macquarie University. It was stimulated by the observation that many students, on enrolment, clearly showed a marked aversion to studying physics and chemistry at the university. Accordingly students, on enrolment, were asked to fill in a form stating their feelings—Love, Like, Dislike, Hate, Neutral/Blank—for the following subjects: Mathematics, physics, chemistry, biology, geology, geography.

In order to make the survey as meaningful as possible the same procedure was carried out at Melbourne University. (Since Macquarie has no engineering faculty the engineering students at Melbourne were not included.) No question of *small* samples arises here, since the numbers were 316 and 548 respectively.

The results and the comments of two university statisticians are given in Appendix II. *Both statisticians agree that there is a highly significant aversion to physics and chemistry in the Macquarie group compared with the Melbourne group.*

There is no reason to imagine that Macquarie students differ from those in the other N.S.W. universities. Nor is the conclusion a surprising one in view of all the evidence presented in this book.

The Education Department appears to have made no attempt to utilise its large research section to ascertain student reaction, although this is quite understandable in view of the response to its teacher survey. However, from my survey and from contacts with numerous parents it is obvious that our local "Science" is driving many potential scientists out of the field altogether. As is well known, there is a general swing away from science in all the Western democracies but here in N.S.W. we are certainly doing our best to accentuate the swing. We badly need something like the Dainton Report which, for the U.K., provided both quantitative data and some concrete suggestions for rectifying the situation.

7. Other Public Criticisms Of The "Science" Courses

Adverse comments have by no means been confined to science teachers and the students directly involved. Criticisms from many university people, usually meeting the course through their children, have appeared in the Press. For example, the Professor of Australian Literature at Sydney University was reported as follows:[16]

"Professor Kramer said that as a general criticism of Australian education, she regarded school and university students as over-indoctrinated and under-read.

"She had to question whether things were better today than they were a generation ago.

"She was more inclined to think the pressure of modern syllabuses made teachers feel that they had to teach flat-out, leaving little time for reading and learning.

"There was evidence in N.S.W. of over-crowding in syllabuses, especially in science courses."

Headmistresses (with one exception!) and headmasters in N.S.W. are not noted for entering the hustings on matters of public controversy. It was all the more remarkable, therefore, to read the following in the Press:[17]

"The Headmaster of Sydney Grammar, Mr. S. P. Houldsworth, said yesterday that the sheer quantity of work done in schools today denied any time to pause and think.

"He said: 'The pupils have no time to dig a bit deeper to allow some of the essential integrity of scholarship to shine through the techniques and principles which have to be mastered.'

"Speaking at the school's speech day in Sydney Town Hall, he said the new syllabuses were not introduced through the generally accepted medium of a pilot scheme running parallel to the old.

" 'In the upper school, there was imposed, at one fell swoop, a tremendous weight of untested syllabus from above. For three years there has been too much,' he said."

Probably the most weighty of the published criticisms came from someone highly respected by both university and science teachers and whose teaching experience in high schools and related areas would far outweigh that of all the "Wyndham science professors" put together.

Because of its importance, it is quoted in full:[18]

"Sir,

"Having been referred to in the letters of Professors Alexander and George (October 10, 11), I wish to state my position regarding the senior high school science courses. It is relevant that I give some background facts—I have been a member of the syllabus committee since 1956, Chief Examiner in Chemistry from 1963-66, once a teacher, and now occupy a position which brings me into very close contact with students entering university. I consider therefore that I should be able to see the matter in better perspective than most.

"In my view:

"1. The dictate of the Board of Senior School Studies that the four sciences—biology, chemistry, geology and physics—be integrated into one composite subject 'Science' with a total subject time allocation of either 1 or 1.5 units was either folly or a direct attempt to downgrade the sciences. (No composite subject exists for the histories or modern languages.)

"2. The demand that the one teacher should handle three or four sciences at this level is not only unrealistic—it is generally unattainable and probably educationally unsound.

"3. The science syllabuses (other than for level 3S) as originally introduced were much too ambitious, grossly over-long, unbalanced, and were not grafted on to the work of the first four years. Even with the optional one-third reduction subsequently granted, the syllabuses are not satisfactory.

"4. The tremendous pressure of attempting to cover the (reduced) syllabus has left little or no time for consolidation, revision, or practical work. There is ample evidence to show that the average student has very limited understanding of the fundamentals of chemistry and has little contact with the laboratory.

"5. There is a critical—even desperate—shortage of properly trained science teachers, a situation which can only deteriorate. The position is scandalous and demands immediate action.

"6. Despite this shortage there are many excellent, indeed dedicated, science teachers. There is no other group which has worked harder since the 'Wyndham' scheme.

"7. The Messel-Wyndham textbook for senior chemistry has good points and bad, but it is quite unsuitable as a general student text. Some of the material is so difficult that many teachers would have trouble in fully understanding it.

"All these facts add up to produce an impasse.

"With regard to first-year university work in chemistry, the situation in the State is probably as Professor Alexander indicated. To the best of my knowledge only Macquarie, with a very small, and I might

add highly selected, intake into the subject is satisfied with the secondary preparation. Competent university staff coping with the remaining thousands of these students express not only disappointment but great concern.

"At Sydney only 30 per cent passed an examination so elementary that it contained a majority of material taken as revision from the 2S (Lower-level) school course.

"It is pertinent to emphasise that the pass rate was obtained with an adjusted pass mark of 50 per cent. I do not for one moment believe that raw-score marks are sacred but we have had long experience with examinations of this type and know what is reasonable even in the current year.

"Of course, our marks could have been scaled to pass 80 per cent of students—but how would the true situation then be known? In fact, the regular passing of 80-90 per cent of students by 'adjusting' marks has been a major factor contributing to the total problem. Unreasonable mark adjustments occurred at the Higher School Certificate examination, and elsewhere I know of a case where the original marks were doubled in an endeavour to cover up unpalatable facts.

"As Professor George is also a member of the Syllabus Committee, and a member of the Board, he should know well that I am one of the academics who have long been pressing for a fairer time-allocation for science and more realistic syllabuses. I believe that my views are shared by many teachers.

"Let it be widely publicised that the senior high school science courses are unsatisfactory and that there is a crisis regarding the supply of science teachers. Unless something is done the system may well collapse and while all this goes on the greatest sufferer is the student—intelligent, mature, but mostly disillusioned about the science he is receiving.

A. J. HARLE,
Director, First Year Studies in Chemistry,
University of Sydney."

(The validity of the first point raised in this letter, namely that the dictate of the Board of Senior School Studies concerning the composite subject "Science" "was either folly or a direct attempt to downgrade the sciences", can be highlighted by stating the current situation in the Faculty of Science at the University of Sydney (and in some others). In the group of first-year science subjects Geography is on exact parity with *each* of Chemistry, Physics, Biology, Geology. According to the assessment of the Board of Senior School Studies, however, Geography in high school education is rated equal to *three* of these sciences put together!)

Just what educationalists overseas think of "Wyndham Science" is well shown by the following letter, appropriately headed:[19]

"Education and Alchemy"

"Sir,

"As an Australian abroad, I read with interest the report by Graham Williams of statements by Professor Harry Messel* on science education in New South Wales.

"Statements like 'the senior syllabus ..... was much superior to anything seen .... elsewhere in the world' and 'N.S.W. is so far ahead in its reform that anything other than this hardly merits discussion' are viewed with some concern because the Australian public may be hoodwinked into believing they are true.

"The N.S.W. syllabuses and associated texts are known overseas, but their standard is considered so low that they seldom merit discussion when compared with genuine curriculum reform movements like the Nuffield Project in England or Project Physics in the United States. In fact the N.S.W. programme is often quoted as an example of how NOT to go about curriculum reform.

"These statements of Professor Messel are indicative of the medieval state of education in Australia and indeed in much of the world. Such thinking about education may be compared to the alchemists' thoughts on the nature of matter in the Middle Ages.

"The question the alchemists asked was simple: How do we turn base metals into gold? First they tried lead as a starting point and were unsuccessful. Then they used copper or various metal mixtures, again without success. Complicated methods of stirring were tried, mystical incantations were sung and bits of this and that were added, all to no avail.

"The alchemist's assistant often had to shoulder the blame for failure. If he hadn't been so dumb, so poorly trained or so lacking in dedication, the transformation to gold would surely have been effective.

"So in education we have some mythical 'gold' standard of excellence we are striving to produce in children. When the Wyndham scheme was first proposed the problem was that the desired standard of excellence in science was not being produced, so the predictable first attempt at a solution was to write a new course.

"The enthusiasm and hope for the future engendered in the authors by their new courses could be likened to that of an alchemist who decided to try a new starting material. The enthusiasm of the rank and file teachers may be likened to that of the alchemist's unwilling assistants!

"Anyway, the new course has not produced the gold standard of achievement desired. So now our educational alchemists have come up with another solution. It was not the course, they say, but the way it was stirred that was at fault; apparently the teachers were so poorly trained that they could not be expected to stir it in the correct manner.

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* See chapter 11.

"Now Professor Messel feels, like the alchemists of old, that the new course would be successful if he personally, or one of his ablest assistants, could stir it in every classroom. Well, of course he can now, through the medium of television.

"Unfortunately, we may confidently predict failure for this venture also—not only on the basis of the alchemist analogy, but also from the results of research into instructional television in the United States in the early 60's. Films and television as instructional media for physics and chemistry produce no dramatic gains in student achievement.

"The other suggestions to 'crash-train' teachers may also be predicted to fail. No crash programme yet devised has produced the dramatic changes in teacher performance or student achievement that apparently Professor Messel envisaged.

"If we continue to ask the wrong educational questions, try to solve meaningless educational problems, or make sweeping generalisations based on 'commonsense' rather than research, like the alchemist we are doomed to failure, and education will continue to exist in the 'dark ages' for some time to come.

"It may fairly be asked, what are the 'right' questions in education? I am not at all sure. The most important thing is that NEW questions start to be asked.

"What are realistic performance standards to be reached by a child at a given stage of development? How do children form concepts? What are effective instructional strategies? Why do we educate and what do we educate for?

GREGORY A. RAMSEY,
Columbus, Ohio.

"(The writer, formerly of Adelaide, is now at Ohio State University.)"

Not surprisingly, "Education and Alchemy" stirred Professor Messel to reply.[20] He first deplored "yet another example . . . . . of how pitifully destructive a number of people have become over one of the world's most successful secondary school science enterprises, namely Wyndham Science", and said later, "The Wyndham science scheme . . . . is one which has received world acclaim".

What evidence could Professor Messel have had for this statement about "world acclaim"? As pointed out again in chapter 11, *any judgment of a course*—whether it receives "world acclaim" or whether it be dubbed "an old bomb"—*can be decided only on the basis of reports from schools where the course has been tried out.* Since "Wyndham Science" is unique to N.S.W. and since the evaluation of teachers and students (supported by university opinion) has been to dub it "an old bomb", readers can make their own assessment of the validity of Professor Messel's claims.

Subsequently an educationalist in South Australia asked a number of pertinent questions,[21] including the following:

"If the programme is as educationally sound as Professor Messel says it is, why aren't the other States adopting it? Those responsible for science education in other States shudder at the thought of Wyndham science."

His letter ends with an interesting proposal:

"I would like to submit that some of the money from the royalties received for the textbooks of the course be made available to conduct a thorough investigation into whether the objectives are educationally sound and are being realised, into what virtues the programme does have, and into whether students and teachers are really contented about it."

I hope that the Senate of the University of Sydney, as the body ultimately responsible for the activities of its Nuclear Research Foundation, will implement this proposal, and so discharge some of its responsibilities to the public.

8. University Reaction To The First Intake Of "Guinea-Pigs"

In March, 1968, the first of the "Wyndham "guinea-pigs" entered the universities. Experienced science teachers had predicted that, despite their extra year and despite having done six years "science", the new intake would be less well prepared for tertiary studies than their predecessors. How right they were!

The first newspaper article on the topic appeared on 21 September,[22] that is, after the universities had had two terms in which to assess the new intake. Regrettably, and surprisingly for an educational correspondent, this article made no attempt at presenting a balanced survey to the public who, after all, are footing the quite substantial bill involved in implementing the Wyndham Scheme. However, it quotes two very critical professors of physics, one saying "Catastrophic" and the other, "The present science course prepares for neither life nor university".

At Sydney University the Dean of the Faculty of Science (Professor Dury) convened a Special Meeting of the Faculty for 26 September. His circulated statement opened as follows:

"Members of Faculty will all be aware that the intake of 1968 has produced severe and unexpected problems. The most serious of these appear to concern a quite widespread lack of basic preparation. While re-scaling can take care of grading in examinations, we cannot fail to be alarmed at a situation which is unlikely to rectify itself; indeed, my own guess is that it could, and probably will, deteriorate still further."

The Faculty also had before it a document from the Director of First Year Studies in Chemistry, entitled: "Some Comments on the Results of the First Term Examination in Chemistry I". It began: "The situation which is revealed can only be described as disastrous, with students generally showing evidence of most serious deficiencies in the following elementary areas" (these are then itemised), and later: "It is senseless to try to build up a study of chemistry if the foundation is as non-existent as the present results indicate. Consequently the following arrangements will operate" (these are then itemised).

These results were obtained from a group of about 1500 students representing, by and large, the cream of the high school science students in the State.

At the Faculty meeting the air of widespread concern was very evident. The view that things were generally better was expressed by only two of those present, both professors closely associated with the

"Wyndham science" experiment. They tried to ascribe any blame to deficiencies of the high school teachers rather than to the new courses, but they received no support even from members of their own staffs. No formal resolutions were passed but further meetings are scheduled in 1969.

How did the other five universities in the State fare? (The Australian National University is included since about three-quarters of its new intake had been educated under the N.S.W. scheme.) Here are some relevant comments from various universities:
From a Chemistry Professor:

"We have been extremely disappointed in the performance of our first-year students in 1968. The belief that they were better prepared for a university course was soon shattered and, although steps were taken in laboratory classes and in (non-compulsory) tutorials to adjust to the apparent decline in performance and interest, the examination results are well below those of any since 1959.

"Our grading of students, which allows 25% of the total marks for the year's work in the laboratory, has placed approximately 50% of them below what we regard as an acceptable pass standard. We may make some provision of a lower grade pass or of supplementary examinations in an endeavour to bring this result closer to that obtained in previous years (72-85% pass rate). These results were obtained with the same examiners, on papers judged to be at least no harder than those of previous years. A solid core of very good examination results is still present.

"I find by consultation that the experience is the same in Physics and Geology."

From a Physics Professor in another university:

"My general impression, therefore, is that the new syllabus has not greatly affected the number of good students (and the good students are not noticeably better than in previous years). On the other hand those students whom we would normally expect to pass by a reasonable margin are now found to have results which make their passes rather doubtful. There seems, therefore, to have been a noticeable but not really extreme deterioration in the quality of this year's intake. This is certainly not what had been hoped for from the Wyndham Scheme and suggests that it represents a retrograde step in the teaching of science".

From a Chemistry Professor in a third university:

"Although most of the students doing Geology I will, for the first time, have had some Geology at school, the Head of the Department of Geology privately reports that the performance this year was worse than in former years."

"We are, commencing next year, planning to devote the first three weeks of first term to a remedial course for all Chemistry I students in

order to try to get them to an effective state to proceed with this subject".

"My personal views on the Wyndham Science Scheme are that, while I can accommodate the idea of a combined science programme up to the fourth year, I doubt that this is a valid proposition in the fifth and sixth years. While the syllabus design is obviously an important question, my belief is that the central problem has scarcely been touched. This is the question of matching the nature of the course which one wishes to give with the resources available in the schools to teach it."

From a Director of First Year Studies in Chemistry in yet another university:

"Students thought university work would be much different from what it is—they seemed to have been 'fed on glamour' and were if anything antagonistic to the remedial work it was found necessary for us to undertake this year. They complained of being bored, yet thought the course was too hard. (This course was given for the first time to students in 1967 without this view being expressed.) Quite a few complained of having hated Science for the last two years. They had lost their feeling of excitement for the subject."

Early this year (1969) an article entitled "Performance of Wyndham Students in University Science"[23] appeared in the *Australian Physicist*. The author's objectives and conclusions are worth quoting.

"It seemed to the present author that the examination results of the Faculty of Science in the School of General Studies, Australian National University, might provide some sort of objective test of the success of Wyndham students, since, of the full-time students in that Faculty, an appreciable fraction (approximately one-quarter) gained their matriculation from other than the N.S.W. system".

The author, having detailed his method of assessment, ends with two conclusions:

"1. In the years 1963-1966 there was no significant difference between the performance of N.S.W. Leaving Certificate students and others in either the physical sciences or the biological sciences.

"2. In 1968

"a. The performance of students from the Higher School Certificate in both Physics I and Chemistry I appears to be significantly poorer than that of those from outside the N.S.W. system.

"b. There is some indication that in Zoology, but not in Botany, the performance of students from the Higher School Certificate is better than that of those from outside the N.S.W. system."

With regard to Conclusion 2b the author writes:

"Wyndham students have studied the biological sciences for six years before entering the University. Few students from the Leaving Certificate entered the University with any previous knowledge of the

biological sciences. It would therefore seem reasonable to expect a marked improvement in the performance of Wyndham students in Botany and Zoology relative to that of their predecessors".

How ill-judged these findings make the early optimism of the Chairman of the Science Syllabus Committee, Professor Butler, who wrote in 1966:[24] "There would seem to me no question that the students should in future be much better prepared than previously to take up university study in physics, and indeed in any one of the science disciplines".

However, one must not be put off by a few statistics. Professor George[25] has "explained away" the unpalatable facts of the Canberra survey on the basis of a small sample and students coming mainly from country high schools.

As regards letters published in the Press we had the amusing experience of one "Wyndham science professor" saying one day that things were all right if university people knew how to teach properly,[26] and just a few days later a letter from a member of his own department outlining the courses in "remedial" high school work which had been found essential![27]

Postscript:

An award for enterprise should go to the publisher who approached one of my colleagues to see if he would write a text-book on "Remedial Chemistry for First Year University Students".

9. Examinations

At the end of their two years of senior "science" N.S.W. students sit an examination based *solely* on the "objective" or "multiple choice" type of question. A typical "paper" (book would be more appropriate!) runs to about 50 pages and has a hundred or more multiple choice questions in it. In these a proposition is stated and the student marks one of five possible explanations or stated consequences of the proposition as the answer. This type of examination has the great advantage that it can be marked by a computer, that is, objectively, quickly and cheaply. No allowance is made for school performance and even the old requirement of submitting practical books has been discontinued.

This is how N.S.W.—the State whose "science course, curriculum and textbooks" "acts as an example and model for other countries of the world"[28]—assesses the educational achievements of its most gifted science students. A student's whole future—whether he matriculates, whether he gets into a university, whether he wins a Commonwealth scholarship and so on—can all hinge on that single examination.

Not surprisingly, public criticism has been both sharp and frequent, as the few extracts quoted below illustrate:

"Those exams!"[29]

"Sir, Elaine Hancock (Letters, October 31) voiced the thoughts of many students, teachers and parents when she complained of the pressure of our education system with its disproportionate emphasis on examination results.

"I worry about an education system which compels students to think and study for years along narrow, prescribed lines to meet a terrifying deadline which, regardless of temperament or current health and circumstances, will label them success or failure on the result of one written examination.

"I urge reform of a system which increasingly is taking all the fun out of growing up.

Josephine Gilmour, Hurstville."

"Professor Couldn't Do Student Exam"[30]

"The Professor of Applied Mathematics at the University of N.S.W., Professor J. M. Blatt, said yesterday he had not been able to finish the N.S.W. final year high school science examination in the set time."

"The examination was part of the Higher School Certificate under the Wyndham scheme".

"Professor Blatt said he worked through the paper after it had been pointed out that a student had to answer at the rate of one question every 1½ minutes."

" 'If a professor can't keep up with the set rate, how can a high school student be expected to do it?' he asked.

"Professor Blatt, who was speaking at a meeting of Scientia, a science body at the University of N.S.W., said the objective answer examination was the greatest crime in the N.S.W. education system.

"On top of this students were crammed for two years with far too much work, and their text books were totally inadequate, he said."

"Exams a Test of Endurance"[31]

"The reported comment of Professor Blatt that he had been unable to finish the N.S.W. Higher School Certificate examination in science in the set time is scarcely surprising when the facts are considered.

"The second-level full course and first-level common paper comprised 50 pages of questions. The total number of questions to be considered by one candidate was 180.

"Every question gave a choice of one right answer out of five possible answers. Not only was one question wrongly printed so that no solution was correct, but often shades of meaning were so close as to be ambiguous.

"No opportunity was given for explaining why one answer was considered correct and the others rejected, which is surely a valid educational objective in scientific training. It could be a valid test of ability to memorise facts and recall them at high speed but not a valid test of the kind of thinking which teachers of science and other subjects are trying to encourage in their pupils.

"The main advantage of objective testing in public examinations lies in the ease of correction by computer. The fact that this has become necessary highlights the absurdity of the high regard in which public examinations are held in our community.

"When the examination becomes a test of sheer physical and mental endurance of a kind no adult could undergo, the situation has become more than absurd; it is highly dangerous for the emotional and intellectual well-being of the young people, who have such tests imposed upon them.

M. D. Roberts, Headmistress, Ascham School,
New South Head Road, Edgecliffe, N.S.W."

(In point of fact there were three errors in the physics and one in the chemistry paper. In biology well qualified biology teachers appear to be in disagreement as to what was the "correct answer" to several questions.)

10. What Has The "Science Experiment" Cost The N.S.W. Community

Is it possible to draw up some kind of "balance-sheet" for an educational change such as the one under discussion? The attempt is worth making, for an imprecise answer is better than no answer. The "pros" and cons" are accordingly listed below, together with some estimates in time or in money terms where this could be done.

On the debit side of the ledger we have the following:

(i) There is overwhelming evidence from teachers, students, and university staff that the aims of a science education as set out in Appendix I have not been achieved. Even after six years of exposure to the subject few pupils have any real understanding of what "science" is, or how scientists approach their problems.

(ii) Many able students are clearly disillusioned, some to the extent that they have moved out of science completely.

(iii) Many science teachers have transferred to mathematics or to some other area; some have quit teaching altogether.

This is a vital question and the Education Department should use its research section to get some quantitative data. In one State School, for example, there are no less than four qualified science teachers, all of whom have given away science entirely for less exacting, and less frustrating, disciplines. Some do this by taking a degree part-time in such areas as arts or economics, whilst still remaining in the public service.

(iv) Science graduates are very reluctant to enter high school teaching.

Until the present mess has been cleaned up no academic taking a responsible attitude to his students could urge a science graduate to teach science in N.S.W., despite the desperate shortage of graduates which patently exists.

(v) Handicap to students embarking on a tertiary education.

As discussed in the preceding chapter, there is clear evidence that students trained under the present N.S.W. "Science" system fare less well in tertiary education than their counterparts from other States.

(vi) Time wasted by students and teachers on errors and obscurities in the "official" text-books and upon experiments which did not work properly.

Although a major point, this is naturally hard to quantify. From discussions with teachers and students it is certain, however, that time

wasted *unnecessarily* would amount to many hundreds of thousands of man-hours.

(vii) Time wasted by teachers (and others) in their efforts to put science education in N.S.W. "back on the rails".

Three science conferences solely devoted to this objective have been held to date. According to the organisers the time involved (organisers and participants) would have run to many thousands of man-hours, and the costs to several thousands of dollars.

(viii) Money wasted by the community on "official" text-books.

I have been given an estimate of 100,000 as the number of N.R.F. senior science texts purchased to date in N.S.W. At $3.00 per volume this would amount to a sum of the order of $300,000. As parents will have discovered by now these books have no resale value, and indeed in some schools there are piles of new books which cannot even be given away.

(ix) Direct financial loss to the Education Department resulting from its policy of handing over its "official" text-books to an outside body.

In other States when a text-book or other teaching aid is given any kind of official *imprimatur* by the Education Department, then in return the body involved is required to return all profits to the Education Department. (This is understandable since profits are inevitable with a virtually captive market.)

In N.S.W. the N.R.F. texts could scarcely carry a more official *imprimatur* than they do, as detailed in chapter 4. Why then did this State, so chronically starved of money for education, forgo its rights to **the inevitable profits?**

(x) Last, but certainly not least, is the harm done to the public image of the universities in general and the University of Sydney in particular. This highlights the urgent need for N.S.W. to adopt the "code of ethics" which operates in Victoria. (The Victorian "code of ethics" expressly precludes any person associated with the development of syllabuses from having any financial interest in commercial ventures related to his activities in the Education Department.)

Turning now to the "credit" side of the ledger I can only find two items for possible inclusion:

(i) The State of N.S.W. has shown the world that it can produce its own course and text-books, both of which are certainly unique (and, fortunately for Australia, likely to remain so)!

(ii) The books have one great merit (as a teacher pointed out to me)—they teach the students to take the printed word with a large grain of salt!

So there we are, parents and taxpayers of New South Wales: that is what the little experiment in senior "Science" has cost us to date. A lot more money is going to be wasted before our children get as good a science education as the other States in Australia already provide, and each year we delay means many thousands more students being quite unnecessarily sacrificed.

11. Official Reactions To Criticisms Of The Senior Science Courses

Public criticism of "Science" in the senior years has now been raging for almost three years. It is surely a remarkable feat that the Director-General of Education, Dr. Wyndham, managed to avoid making a single public comment (to the best of my knowledge) right up to the time of his retirement in December, 1968. His views and reactions have therefore to be assessed indirectly, mainly from meagre press reports and from answers by the Minister for Education to questions asked in the N.S.W. State Parliament.

The nearest to a public comment from Dr. Wyndham is the letter sent by him to the organisers of the Science Conference in December, 1968, and distributed to all attending. After regretting his inability to attend since "I am committed to meetings in Canberra until late on Friday evening and shall not be able to be back in Sydney until about the time your conference is due to conclude", he went on:

"I do think it would be desirable for the conference to hear something from a competent person on the purpose of the Science Syllabuses, particularly in secondary schools in N.S.W. Indeed, I would think that such a person as the Chairman of the Science Syllabus Committee would, in any event, be more competent to speak on this topic than would I. I think that a paper, however short, would be desirable, especially since you have invited speakers who doubtless will be representative of points of view in regard to science syllabuses which are in contrast to that developed in N.S.W. In this connection, I would hope that your conference is made aware of the outcome of the recent Unesco Conference on the teaching of Science, a conference at which the N.S.W. syllabus was thoroughly and favourably reviewed".

What basis could there have been for the statement that "the N.S.W. syllabus was thoroughly and favourably reviewed"? (Incidentally it was not a Unesco Conference, it was a meeting of the Inter-Union Commission on Science Teaching.)

One does not need a degree in education to know that the only way in which a syllabus can be "reviewed" is on the basis of reports from schools where that syllabus has been tried out.

Where had the "N.S.W. syllabus" been tried out? In N.S.W. only. And what reports were available from those who had taught the syllabus? The motions from two very condemnatory conferences (chapter 5), plus the pre-circulated draft resolutions for the 7th of December Conference, proposing to toss out the "N.S.W. syllabus" lock, stock and barrel.

Scarcely a sound basis for a Director-General of Education to state that "the N.S.W. syllabus was thoroughly and favourably reviewed"!

The only really relevant press report[12] appeared on Sunday, 8 December, 1968, that is the day following the Science Conference which dubbed the senior science syllabuses an "old bomb" and which passed by about 400 votes to 5,* a resolution saying: "The existing science syllabuses for the N.S.W. Higher School Certificate are unsatisfactory and this Conference demands that new syllabuses be prepared." This press article stated: "Dr. Wyndham stands four-square behind the course, the syllabus and the text books". (This reminded me of the old story about the Ruritarian General leading his troops—"Everyone out of step except me".)

Following the Science Teachers' Conference held in 1967, and referred to in chapter 5, a number of questions concerning the science course and text-books were asked in the N.S.W. State Parliament. The questions and answers, as officially recorded, are reproduced below.

Questions Without Notice, 8 November, 1967.
Federation Science Teachers' Association

Mr. Mackie: My question is addressed to the Deputy Premier, Minister for Education and Minister for Science. Has his attention been invited to reports following a conference of the Federation Science Teachers' Association concerning the science syllabus, the staffing of science classes and the use of science equipment in our secondary schools? Are the reports in accordance with the position in the department and is the Minister able to comment further on these vital aspects of our education system?

Mr. Cutler: During the past day or two I read in the press a report of a conference held in Sydney last Saturday, convened in the name of the Federation Science Teachers' Association. There is, of course, a New South Wales Science Teachers' Association, which is part of an Australia-wide body that is held in very high repute indeed. I understand that members of the parents and citizens' associations also were invited to attend the conference last Saturday. So far as I can ascertain, the conference considered quite a number of matters. The first one, as mentioned by the honourable gentleman, was the science syllabus for senior secondary forms. I think members of the conference which was called by the Federation of Science Teachers' Association must have been very well aware of the fact that the syllabus to which they referred in the press article was already the subject of consideration and review by the Board of Senior School Studies. They must have been aware of this fact, teachers of science throughout the State having been informed that this was to be done. It seems to me that the pattern was followed of finding out something that was in fact happening or was about to happen, and then having a meeting to

* According to the organisers the few dissentients were all members of the "Wyndham science group".

demand that it should happen. This can be a very effective method of publicity. In addition, the conference had something to say, I gather, about the text books published by the Nuclear Research Foundation for the senior science course. There appears to have been some confusion on the part of those who attended the conference. As honourable gentlemen know, the science books published by the Nuclear Research Foundation fall into three categories: the work which covers the first four forms; second, an abridged version of the book for the first four forms; and third, Science for Senior Secondary Schools, which is published in three separate volumes.

The conference drew attention to the fact that the books contained a foreword by the Director-General which had been approved by the Minister for Education of the day but in respect of Science for Senior Secondary Schools this was not so. The Nuclear Research Foundation published these books of its own accord and also published the foreword, still by the Director-General of Education, but this time without his knowledge.

Questions Without Notice, 15 November, 1967.
Science Textbook

Mr. Booth: My question without notice is directed to the Deputy Premier, Minister for Education and Minister for Science. It relates to the answer to the honourable member for Albury concerning the foreword by Dr. Wyndham, which was printed without his consent in both the chemistry and physics textbooks. Are these the books which state that they were prepared with the co-operation of the Department of Education for High School students? Are these statements misleading and are these books most unsuitable for fifth and sixth form students? What does the Minister intend to do about having the foreword withdrawn and parents and pupils, and parents and citizens' associations, informed of the inadequacy of these books as expressed by the Science Teachers' Association?"

Mr. Cutler: I will have a look at the question asked by the honourable member for Kurri Kurri and give him a reply later.

Questions without Notice, 21 November, 1967.
Science Textbooks

Mr. Durick: I ask the Deputy Premier, Minister for Education and Minister for Science, whether on 8th November when replying to the honourable member for Albury he said that the Nuclear Research Foundation had published a textbook, Senior Science for High School Students, which included a foreword from the earlier science textbooks which had been included without the knowledge of the Director-General of Education? Has the Minister taken the trouble to inspect all three volumes in which there is a foreword by Dr. Wyndham, the Director-General of Education, dated January, 1966, in which he says that the success of the earlier work led the writers to further adventure resulting in the production of Senior Science for High School Students?

Does not Dr. Wyndham say also in the foreword that "the outcome is the present series of text books, Senior Science for High School Students, carrying on from where the authors had left off at the end of the four-year science course and taking the student through to the end of the sixth year of secondary schooling"? Will the Minister now admit that the answer he gave earlier was misleading and that the confusion to which he then referred existed not in the minds of science teachers, whom he tried to belittle, but in his own?

Mr. Cutler: In answer to the latter part of the question, I did not try to belittle the science teachers, but the honourable member is belittling them by saying such a thing. In fact our science teachers have done a very good job, and I commend them for what they have done since the implementation of the Wyndham scheme. Early last week the honourable member for Kurri Kurri asked me a question almost along similar lines to that asked today by the honourable member for Lakemba. I was in error when I said that the foreword to the senior portion of the science textbooks was not prepared by the Director-General of Education. The forewords for the original science textbooks were prepared during the term of my predecessor in this portfolio. Dr. Wyndham, the Director-General of Education, wrote those forewords. I am not aware whether my predecessor gave his approval to the foreword that was written for the books for the higher secondary level. Dr. Wyndham did write the foreword to the senior science textbooks, and I did mistakenly inform the House that he had not done so.

Questions Without Notice, 22 November, 1967.
Senior Science Textbooks

Mr. Cutler: On 15th November the honourable member for Kurri Kurri asked me a question without notice relating to senior science textbooks. I provided a part answer to this question yesterday in answer to a question by the honourable member for Lakemba. I am now providing a detailed reply on the other matters raised.

The textbooks to which he referred are part of a series of five. The whole series had the support of the Minister of Education of the day. The first two texts, relating to the work of the first four secondary school years in science, were prepared with the co-operation of the Department of Education because of the urgent need for science texts at that time and have been in use in many schools for six years. The last three of the series, designed for use by fifth and sixth form students, were the work of outstanding scientists in the universities. The writing and publication of the books were on the initiative of the Nuclear Research Foundation which, in respect of these books, did not seek the close collaboration of the Department of Education which had been forthcoming in respect of the earlier books. Certain science teachers did, however, in their private capacity, collaborate in the preparation of these senior texts.

The senior texts in question are not unsuitable or inadequate for fifth and sixth form students and I have no intention of advising

parents to that effect. The texts were written by outstanding authorities at a time when there were no comparable texts available relevant to the new syllabuses in science. They were written by professors who, next year, will be teaching some of this year's sixth form students. I should point out that neither these nor any other books are set or required texts for the senior course in science. If the books are considered inadequate by some of the teachers these teachers are at liberty to choose better texts.

Who in the Education Department supplied the Minister for Education with the information that the Director-General's foreword in the Nuclear Research Foundation's senior texts was published without his knowledge? What was the point in giving Parliament information which could so readily be shown to be false?

Of the many mysteries surrounding "Wyndham science" this is surely one of the most inexplicable.

As regards public defence of "Wyndham science" by members of the Board of Senior School Studies this appears to have been limited to a single letter in the Press,[26] but it made no serious attempt to answer criticisms. (The writer was a contributing author to one of the N.R.F. texts.) I received one private letter from a member of the Board in which he ascribed the lack of trial runs to lack of time. However, this excuse cannot be taken seriously since the Board had four clear years to work out its new policy and test its courses.

In the absence of any serious attempt by the Board of Senior School Studies to defend "Wyndham science" the main defence has come from Professors S. Butler and H. Messel, both from the School of Physics, University of Sydney.

To my first letter (8 December, 1966) which strongly criticised the N.R.F. text-books and included the phrase "It seems that our students and teachers in N.S.W. are being made the guinea-pigs of an unnecessary experiment" Professor Messel replied as follows:

Textbooks for Science[32]

"Sir—I refer to Professor A. E. Alexander's letter (Dec. 8)[1] in regard to science books for fifth and sixth years. It is most unusual to enter into public debate on the merits or demerits of scientific textbooks and I have no intention of doing so. These are matters which can best be discussed in the traditional method between the academics concerned. However Professor Alexander's letter is so mischievous and misleading that at least a number of the points involved must be put straight.

"First, we are well acquainted with the American and British textbooks brought out to meet their current science curriculum reforms. Equally well, these groups are well informed of our efforts which have received world-wide acclaim. Our books are at present being adapted by the British for use in Great Britain where already, in some cases, integrated science is being considered.

"The British books are based on their syllabus and the American

ones on theirs, neither of these embrace the concept of integrated science—a concept which both countries hope eventually to embrace and thus to emulate our efforts in Australia. Where integrated science is considered, our books are being used.

"The American texts to which Professor Alexander refers have little relevance to our secondary course. They are written for students taking a one year course of either physics or a one year course of chemistry during the student's total High school science course. Our fifth and sixth year texts are based on the fact that all our students in reaching their fifth year will already have had four years of integrated science, including among other things physics and chemistry. Other than being used for reference material, it is difficult to see how the American texts could be used here. However, many of the concepts in these texts were kept in mind when our texts were prepared.

"The reference to Victoria and Tasmania is equally misleading. They do not have a six-year integrated and interlocked science syllabus. In due course, when the Americans and British have one, they will undoubtedly follow suit and endeavour to catch up with us. In the meantime, New South Wales can proudly continue to lead the field with no serious contenders. Professor Alexander's remarks imply the scrapping of the integrated Wyndham science course.

"One final word of advice to Professor Alexander. Criticism is simple and takes little time, especially mischievous criticism. Action is much more time-consuming as I can verify. May I suggest one of two courses to him. The first would be to take time out to come and talk to me personally or give me in writing his detailed criticisms; these would then be considered during revision of our books. (The same remarks apply generally; we would genuinely be grateful to receive constructive criticism and suggestions for the books which could be embodied during revision.)

"Secondly, if Professor Alexander is totally dissatisfied then let him sit down and write what he considers to be suitable texts himself.

H. MESSEL."

In May, 1967,[33] I raised the matter again and included the paragraph:

"I urge the N.S.W. Minister for Education to ask the Australian Academy of Science, as a body deeply concerned with science teaching in Australia, to nominate a panel of scientists and teachers to give him an expert and unbiassed evaluation of the text-books currently used in N.S.W. and of the potential value of Nuffield Science in the junior years".

Needless to say it was ignored by the Minister for Education (Mr. Cutler) but it did elicit a reply from Professor Butler, the Chairman of the Science Syllabus Committee.

Professor Butler wrote as follows:[34]

"Sir—I refer to the letter by Professor A. E. Alexander (May 17) in which he criticises the N.S.W. Education Department for 'com-

missioning new texts for the senior science courses': and recommends that its 'ill-advised experiment be discontinued and that it should use the well-proven first-class American High school texts, evolved under the auspices of the National Science Foundation, as all other States in Australia are very wisely doing'.

"He goes on to urge the N.S.W. Minister for Education 'to ask the Australian Academy of Science, as a body deeply concerned about the science teaching in Australia, to nominate a panel of scientists and teachers to give him an expert and unbiassed evaluation of the text-books currently used in N.S.W.'

"These remarks are fraught with confusion, as was highlighted by the points made by M. Cullen (Letters, May 22). This is very surprising, as Professor Alexander has had more than five months to acquaint himself of the true situation since his previous criticisms (Letters, Dec. 8, 1966).

"To start with no textbooks have been commissioned by the N.S.W. Education Department.† All science courses at secondary school level are defined by syllabuses prepared by syllabus committees set up by the Education Department. Teachers and schools are free to choose any guiding texts which are available for the teaching of these courses.

"The textbooks published by the Science Foundation for Physics* within the University of Sydney were written explicitly to the N.S.W. science syllabus and are perhaps the texts to which Professor Alexander refers. They consist of 'Science for High School Students' (S.H.S.) and 'Senior Science for High School Students' (S.S.), the latter appearing in three volumes covering the subjects physics, chemistry and biology for fifth and sixth year science courses. The fact that these books are being extensively used in schools is a reflection of their value; they have not been compulsorily 'inflicted' by the N.S.W. Education Department.

"The Science Foundation texts have, incidentally, created much interest overseas and have been reviewed enthusiastically in the United Kingdom and the United States. I quote, for example, from a leading review in 'Nature' (July 2, 1966) concerning the physics volume of S.S., whose panel of authors included both university members and high school teachers: 'There is no reason to doubt the authors' claim that certain concepts and the mode of their presentation have never before appeared in a school text. In Britain, books at this level tend to be written by schoolmasters and although usually reliable and sometimes distinguished, are usually derived works and seldom contain anything so fundamentally different as to give one a mental start. The physics section of 'S.S.' does just this. It continuously excites and makes the reader eager to press on and follow a theme to its conclusion. 'Those

† Contrast this with the statement by O. A. Guth (chapter 4) that "the Education Department has invited Professor Messel to produce follow-on text-books for the fifth and sixth year science course."[9]

* Formerly the Nuclear Research Foundation.

of us who work in schools have reason to thank members of university faculties who give part of their time and energy to write texts of this nature'. Many other such reviews, as well as favourable comments from individual scientists, have been received.

"It becomes clear, however, that Professor Alexander is really criticising not textbooks but the N.S.W. science sylllabuses themselves and he should make this clear. He advocates the automatic adoption of such courses as those planned under the auspices of the U.S. National Science Foundation. I was, in fact, quite closely associated with many of the people involved in the physics part of this U.S. course and am well acquainted not only with the final product but also with the aims and motivation of those responsible for it.

"It was designed as a one or two year college course in the U.S. assuming no previous physics knowledge, and thus for a completely different purpose from that required for the physics content of the senior science course in N.S.W. It was analysed in detail by the physics working group of the Senior Science Syllabus Committee and use was made of this course where appropriate.

"The senior science course in N.S.W. must, however, cater for students who have had a four-year integrated science course, to be followed by two years of senior science. The existing N.S.W. course must and does take students considerably further in physics than the American course referred to by Professor Alexander. I understand that the same remarks apply also to the other scientific disciplines.

"There is no doubt that good courses for specific purposes have been planned in overseas countries. These must be taken into detailed consideration in the planning of courses in Australia, as indeed they were. But it is not necessarily true that they can be adopted wholesale to an educational system such as the Wyndham system in N.S.W. The science syllabuses which have been prepared in this State for the purpose of the Wyndham scheme are, in fact, being analysed with great interest overseas and may in turn have considerable influence on modifications of courses to be made in the United Kingdom and the United States. They are also playing a significant role in discussions at meetings of the UNESCO Science Teaching Project.

S. T. BUTLER,
Professor of Theoretical Physics,
University of Sydney."

Both Professor Butler's letter and that of a Mr. Cullen who wrote supporting him were rather beautifully answered by a teacher:[35]

"Sir—If, as Professor Butler claims (Letters, May 24), Professor Alexander's remarks (Letters, May 17) 'are fraught with confusion' then Professor Butler's letter and that of M. Cullen (May 23) add to the confusion by certain distortions (by omission) of their own.

"It is a pity that Professor Butler and Mr. Cullen did not mention that they are two of the co-authors of the senior science physics volume, since this would have established at once that their letters in defence

of the N.R.F. texts are offered from partisan positions. With regard to these senior science books (which Professor Alexander specifically condemned in his opening paragraph) Mr. Cullen is pedantically correct in saying that the books were not 'commissioned' by the Department of Education.

"However, he could also have adduced the following facts: one of the three executive editors is identified as 'Staff Inspector, N.S.W. Department of Education', each of the three volumes carries a laudatory foreword by Dr. Wyndham ending with this sentence: 'The Department of Education in N.S.W. welcomes the unique contribution of the N.R.F. to an exciting enterprise'. These N.R.F. books may not have been 'commissioned' but they appear to carry what looks like a departmental *imprimatur*.

"Professor Butler comfortingly quotes the favourable review in 'Nature' of the physics volume. Whose estimation of the book is more likely to be correct—a person who reads it to write a review, or teachers who work from it consistently over 15 months? Professor Butler nowhere mentions the opinions of science teachers. These were made abundantly clear at two representative meetings of High school science teachers last year when the books were comprehensively and bitterly denounced.

"Understandably, most schools chose N.R.F. and in a world of school textbook hiring services this means that the schools are stuck with them, errors, obscurities and all, until the school treasurer decides that an economic mileage has been obtained from them. In the meantime, as Professor Alexander observed, it is the students and teachers who suffer—not the authors."

When towards the end of 1968 "Wyndham science" was under renewed attack in the Press, Professors Butler and Messel again rallied to its rescue. Professor Buter's letter said much the same things as his earlier one: Professor Messel's is reproduced below.[28]

"Sir—I have just completed attending two important overseas international conferences on the teaching of science in secondary schools and feel that it is important that the people of Australia should be factually informed of the main results. Here are some of the major facts:

"The Varna International Conference on the integration and teaching of science at the secondary school level was held in Varna, Bulgaria, from September 11-19. It was attended by the leaders of every major science curriculum reform group of the world—including, of course, the Nuffield group from England, the various groups from the U.S.A. and so forth.

"The conference recommended without reservation a system of secondary science which turned out to be the exact replica of that now in effect in N.S.W. Congratulations to Australia and N.S.W.!

"I have passed on to the N.S.W. Director-General of Education

copies of the final report carried by the conference. This report to UNESCO and other international bodies carries as an appendix my paper on the N.S.W. science course, curriculum and textbooks and acts as an example and model for other countries of the world.

"How out of keeping all of this is with the continued attacks in the 'Herald's' Letters columns on the Wyndham science course?

"The people of N.S.W. should be proud of the Wyndham science course and the lead that it has given to science curriculum reform around the world. It is an example which will in due time be adopted by other States of Australia, though this will probably come about in a roundabout and amusing fashion—the N.S.W. scheme will be re-imported from overseas!

"Now in regard to the Science Foundation textbooks covering most of the six-year N.S.W. science course. These are at present being translated into French, German and Japanese. The English adaptation of our books for their C.S.E. standard is to appear on February 1 in 13 volumes.

"I could write at great length on all these matters; suffice it to say that N.S.W. has much to be proud of in its science course and text-books covering it.

"This is not to say that we should become complacent and not improve our courses and textbooks further. Thus, as the various science curriculum reform groups around the world move towards an integrated and co-ordinated secondary school science course such as that of N.S.W., we should and will continue to amend and improve both our curriculum and our textbooks, in the light of the experience gained both by teachers and students.

"Constructive help and comments by all concerned will as always be appreciated by us and both teachers, parents and students should not hesitate to continue writing to me as in the past.

HARRY MESSEL,
New York, U.S.A.

"P.S.: I will even be pleased to receive Professor Alexander's constructive suggestions if he has any. I have given this invitation a number of times previously but received no sensible suggestions. H.M."

One of those odd coincidences which occasionally happen in real life led me (tongue in cheek) to publish the following letter:[36]

"Sir—On the same day as I read Professor Messel's stirring account of how 'the new science of N.S.W.' was sweeping the world (Letters, Nov. 19) I received an invitation from the N.S.W. Secondary Teachers' Association to attend a conference. The invitation states: 'The purpose of the conference is to achieve the early introduction of worthwhile science courses for the N.S.W. Higher School Certificate. It is being convened because of widespread dissatisfaction with present senior science courses in N.S.W. secondary schools'.

"The science teachers (or is it the students?) in this State must be a stupid lot.

"Let us all pray that Professor Messel finds his polar bears both more intelligent and more appreciative". (According to a press report, Professor Messel was at the time on leave in Alaska, attaching transmitters to polar bears!)

And subsequently, with tongue even more firmly in the cheek, I answered his postscript seeking constructive proposals to improve science teaching in N.S.W.[37]

"Here are two which I know both students and teachers will acclaim:

"(1) That the executive editor, authors and publishers (the Nuclear Research Foundation) of his high school texts pay all the profits derived from the parents and teachers in this State into a trust fund at the Education Department, the fund to be used to enable High schools to purchase replacement texts.

"(2) That he persuades those responsible for the present situation (which seems basically to be the authors of the texts referred to above) to resign from the Science Syllabus Committee, so that a fresh start can be made in 1969".

Needless to say these suggestions were not acted upon.

Before leaving the subject of the Varna International Conference there are a few points to be mentioned.

Professor Messel's letter from New York, published in Sydney on 19 November, 1968, states: 'The conference recommended without reservation a system of secondary science which turned out to be the exact replica of that now in effect in N.S.W. Congratulations to Australia and N.S.W.!

"I have passed on to the N.S.W. Director-General of Education copies of the final report carried by the conference".

The General Report of the Varna Conference, made available by the Education Department in connection with the "rehabilitation" discussions mentioned later (chapter 12), is reproduced as Appendix III. It makes no reference to the N.S.W. courses but it does contain the very important and relevant statement: "But it is useless for educationalists quickly to write a syllabus for a course and then expect it to be taught successfully. A great deal more is required in the way of planning, testing and implementation—all rather lengthy and costly processes".

In January, 1969, an article by H. Messel and E. N. Barker (the latter from the N.S.W. Department of Education) entitled "The general philosophy behind the new integrated and co-ordinated science courses in New South Wales and the Science Foundation for Physics† textbook

† Formerly known as the Nuclear Research Foundation.

series", was published in "Physics Education" (London).[38] The most relevant excerpts and its final summing up are quoted below.

"The Foundation's Science Textbook project arose from the reorganisation of secondary education in New South Wales, generally known as the Wyndham Scheme. The book project was a unique effort to endeavour to solve the many problems arising from the implementation of new science courses which were part of the Wyndham Scheme —itself a most significant departure from the previous system of secondary education.

"The new science courses were so radically different from the traditional courses previously studied that when the new syllabuses were prepared there were no textbooks in existence which could adequately and specifically cover them or give the necessary guidance to teachers now compelled to prepare lessons in unfamiliar fields. Furthermore the whole outlook and philosophy towards the teaching of this new science were different from anything the teachers had faced before.

"Professor Messel recognized the problem and proposed the creation of, and led, a specially chosen group of scientists, teachers, lecturers and administrators to prepare the much needed textbooks. He decided to invite the Science Foundation for Physics, of which he was Founder and Director, to become the publisher of the textbook series. The Foundation in turn chose the Government Printer of New South Wales as the printer for the series".

"Teachers are free to choose their own textbooks although they must cover the prescribed course. . . . . It should be noted however that the writing groups associated with the textbook project included many members of the syllabus committees, so guaranteeing a correct interpretation of each syllabus. The same remark applies to the examination committees."

"The course was to be based on experiment and observation with stress on the proper evaluation of evidence."

"The examination committee indicated that, at the terminal examination, it would aim to assess understanding of principles rather than the reproduction of memorized proofs."

"An appraisal 1968.

"The School Certificate Science course, which has been taught for six years, is firmly established in New South Wales and has won almost unanimous acceptance. The standards of achievement as revealed by examinations are satisfactory and there is evidence that the wider aims of the course are being given increased emphasis.

"Although experience of the Higher School Certificate courses is limited, three things have become clear: the modern forward looking content has won general approval; specialization at the senior level is undesirable and students should retain contact with at least three scientific disciplines, and all students of science need adequate grounding in chemistry and physics.

"The third-level course has proved to be very popular, while of the second-level courses, the short course (2S) has received strong criticism, although this has been moderated with experience.

"Revision of the courses is needed to remove the *deficiencies that have been revealed** and to form a more effective link between the junior and senior syllabuses. Thus it is likely that in 1970 a revised fifth and sixth year syllabus will appear, followed by a revision of our fifth and sixth year texts. However, traditional approaches have gone and any revisions will be a consolidation, not a retreat".

Also in January, 1969, Professor Messel was given a full-page article in the local Press for a lengthy reply to his critics.[39] Apart from a couple of factual statements which are incorrect, the article is too diffuse to make detailed criticism possible. The first incorrect statement is the following:

"The Senior Syllabus, like the Junior one, was prepared in great haste and under considerable pressure to have it out in time for the first Senior School year—1966".

As pointed out previously, the Board of Senior School Studies had *four clear years* to work out the Senior course and if the advice of the scientists from the professional conferences had been followed the Senior course would have been introduced as smoothly as it was in other States.

The second statement, which is clearly contrary to all the evidence presented in this book, is the following:

"It is true that the original Senior Syllabus was far from perfect. However it was much superior to anything seen previously in the schools of N.S.W., the other States of Australia or elsewhere in the world".

It was a pity Professor Messel did not accept the invitation to attend the Science Conference which tossed out his "superior" syllabus neck-and-crop, the "superior" syllabus which one teacher described as "the worst syllabus in the history of science education" and many others as an "old bomb"!

As a group of fourteen practising science teachers wrote in a letter:[40]

"We hope Professor Messel will be able to attend the science syllabus conference to be held at Sydney Boys' High School on December 7. He would then have an opportunity to explain why the N.S.W. senior science syllabus is so warmly received in Bulgaria when it cannot find supporters in its own State, and has been given the cold shoulder by our nearest neighbours, Victoria and Queensland"!

Subsequently to his long press article, Professor Messel has expanded his thoughts in an elaborate printed booklet of 20 pages (available gratis from the University of Sydney Physics School). It

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* My emphasis.

carries the crest and title of the University of Sydney on the cover and would look a most official document to a naive politician or uninformed parent. (According to the Registrar it was paid for from Nuclear Research Foundation funds.)

Not surprisingly it makes no attempt to explain any of the real mysteries of "Wyndham science", but it does at least admit that science in N.S.W. high schools is in a mess for it asks the question, "Who was, and is, to blame for the mess?" After an "analysis" of the situation, it concludes: "Thus, the blame for the present situation lies fairly on the shoulders of the citizens and in turn on the Governments of this State"! Mr. Cutler, please note!

Educationalists will find this document a real eye-opener and should certainly make it prescribed reading for all their students. Teachers in N.S.W. and other States will read with particular enjoyment the two following statements:

"It is such judgments throughout the world which highlight the reputation of the books—judgment by world authorities and not by the ravings of a few jealous and prejudiced individuals nearby."

"It is amusing to read of attempts by other States in Australia (which have in fact just been playing with the problem and using patchwork methods) to get N.S.W. to join them in their science reform efforts". (See chapter 5.)

However the concluding paragraph really caps the lot.

"Thus, students coming to the University of Sydney and majoring in Physics will not only have had a six year integrated–co-ordinated science course, but a ten year one! Where else in the world can this be equalled?"

The answer to that is, thank heavens, nowhere!

Postscript:

As we go to Press the Chairman's Report of the Science Foundation for Physics, dated 8 May, 1969, has just come to hand. It includes the following paragraph:

"Speaking of science syllabuses and our textbooks, you will no doubt have all noticed in the Press during the past years criticism, particularly in the letter columns of certain newspapers. These criticisms were made by a small but vocal minority. I am glad to report that once again Professor Messel—in writing an explanatory pamphlet on Wyndham Science—has helped put matters more into their true perspective."

12. Rehabilitation

How can we get N.S.W. science education back on the rails as quickly as possible? Anyone who has had occasion to tackle a "public service" department (in any country) knows that the doctrine of infallibility is certainly not confined to the Pope, so that hopes of a frank admission of a blunder and a start with a clean sheet is probably expecting too much.

The science teachers, through their various conferences, and in particular through the motions passed at the last one, have certainly made their point-of-view crystal clear. Individual science teachers, in addition to supporting the efforts being made by their associations, can also make a further direct contribution towards rehabilitation. This can be done by joining the growing band of teachers who have given up using the N.R.F. texts, both for the junior as well as the senior work. Educationally better texts, both for the junior and the senior courses, are now available so that teachers can not only express, in a concrete way, their opinion of those who foisted "Wyndham science" upon them against their expressed wishes, but also help their students at the same time.

Science education in high schools is something which all the various scientific organisations, science-based professions and industry can ignore only to the detriment of their long-term interests. The Institute of Physics in N.S.W. has been particularly active in making direct representation to the Board of Senior School Studies—others could and should follow suit. Furthermore when such a basic matter as science education involves the most populous and most industrialised State in Australia, even the Federal Government can scarcely turn a blind eye, touchy though States can be to the Commonwealth "sticking its nose" into educational matters. The science-based industries, unfortunately, do not yet appear to have realised just what "Wyndham science" is doing to the training and supply of scientists at all levels, but any industrialist has only to talk to any science teacher he knows in high school, technical college or university, to realise that there is plenty of cause for alarm.

As regards parents, few would feel sufficiently knowledgeable to enter into public controversy but they can nevertheless exert more pressure than they realise through their local members of State parliament and through such bodies as the Parents and Citizens' Association. (Parents and Citizens' Associations should be particularly interested in the matter of quality of text-books, in view of the large sums parents spend each year buying or hiring text-books.)

As parents our first demand should be that the science education available to our children should not be inferior to that in other States. This would mean, in particular, that courses of proven value in other States should be available here and that N.S.W. co-operates with other States in *all* curriculum development projects for both senior and junior science. It is only by a co-operative effort that sufficient resources are likely to be available to undertake successfully such difficult problems as a genuine "integrated" course, as the Varna Report makes clear.

Unfortunately the N.S.W. State Government has so far not displayed the same interest in the problems of science education as it has, for example, in those of the Opera House. However, since the main reforms sought by virtually everyone involve little or no expenditure, the Minister for Education should be susceptible to a little pressure. In fact, if the Minister were prepared to take a leaf out of the Victorian and South Australian books, he should be able to achieve substantial reimbursement from the Nuclear Research Foundation for its use of the N.S.W. Education Department's *imprimatur* as discussed in chapter 10. He could then earmark this money for the rehabilitation of science education in our high schools.

Regardless of what the Minister does, the Senate of the University of Sydney should issue a full and frank statement concerning the N.R.F. textbooks and the University. The statement should clarify the matter of copyright and should set out in detail the financial arrangements between the Nuclear Research Foundation, members of the university staff and outside organisations. There can be no valid reason why a full disclosure should not be made, for universities are not commercial enterprises and are not in the business of education in order to make money out of parents. *Furthermore university staff expect, and have so far been given, a freedom quite unparalleled in any other group of professional people paid from public funds.* In return for this freedom the public can very properly expect that academics will state quite openly what extra-mural activities they engage in and what remuneration they obtain from such activities. Governing Bodies of all universities could take immediate action in this respect if they so wish.

Even if all the above suggestions are rapidly implemented, however, it will be virtually a decade before all the effects of the present science courses can be removed from the N.S.W. educational system. In the meantime many tens of thousands of students will have received a science education much inferior to what they could have had and would have had if the consensus of professional opinion had been followed.

Whether the lesson has yet been learned and whether the 1968 Science Conference has made sufficient impact to initiate genuine reforms will be very evident well before the end of 1969. However, at the time of writing, one small but positive step has been taken by the new Director-General of Education: representatives from the various

teachers' organisations and other critics were invited in January to put forward positive suggestions for improvement of the Syllabus and later to meet the members of the Board of Senior School Studies. According to the teachers this in itself was quite a unique happening.

Following this meeting in February, the Board referred both criticisms and suggested remedies to its Science Syllabus Committee. Just what was expected from such a referral is not clear. The Board could scarcely be so naive as to imagine that a body containing so many of the group whose syllabus and textbooks had been so scathingly denounced (as detailed in chapters 5 to 9), could be expected to make a detached evaluation of these criticisms and proposed remedies!

The Science Syllabus Committee, at two meetings in March, considered the proposed remedies and in particular those from the two major science teachers' organisations (representing between them some 90% of all the science teachers in the State). These proposals, which are given in Appendix IV, were recently overwhelmingly endorsed by the members of the Faculty of Science at Sydney University, and would certainly be equally strongly supported by all the other universities in the State.

At its second meeting the Science Syllabus Committee, whilst accepting proposals 1 and 3, rejected the key proposal (number 2), namely that single sciences be permitted in such schools as wished to offer them. (Note "wished"—no suggestion of compulsion.)

What lay behind their rejection of a proposal which is scarcely revolutionary, being the existing state of affairs in every other State in Australia? As a report from the science teachers' organisations to the Board points out, no educational arguments of any substance were advanced for this rejection.

The likely but unstated reason is that if some of the modern science courses which have proved so successful in other States (see chapter 3) *were allowed to compete on equal terms with "Wyndham science" in N.S.W. the "Wyndham science" courses would very rapidly find themselves without students!*

Nothing would more convincingly expose the hollowness of the claims made for "Wyndham science" by its few supporters.

If the education and careers of our children were not at stake it would be quite amusing just to sit back and see how much longer the handful of "Wyndham scientists" can continue to thwart the expressed demands of the teachers, the students, the academic community and the professional science institutes. After all, the fantasy of "Science with a capital S" must come to an end one day!

APPENDIX I

A Suggested Set of Objectives for the Syllabus Construction Group

Senior secondary science syllabuses should provide courses which are based on the following behavioural aims:

- awaken and maintain a sense of adventure and achievement and thus develop a student with an increasing tendency to be creative, imaginative and appreciative of natural phenomena, scientists and scientific endeavour;
- foster an understanding of the historical background and philosophy of science;
- develop the student's powers of self-expression.

Further, that any Syllabus Construction Group should design courses which can be viewed in terms of the following criteria:

- all courses should be complete and consistent, that is designed to consolidate the first four years of science and not specifically directed at only those students proceeding to tertiary studies but adequate for those wishing to do so;
- be capable of being taught through deductions made from observations and experiment with adequate time for the development of manipulative skills and the ability to observe intelligently and record accurately;
- allow time for students to follow up the consequences of their own reasoning and observations;
- show the scope and usefulness of scientific method, while revealing the existence of uncertainties, boundary problems and alternative theories to explain the same set of facts;
- the syllabuses should not be over-prescriptive and should allow for teaching to be flexible and progressive, taking advantage of new methods and new ideas, and tailored to the maturing abilities of the student.

APPENDIX III

C.I.E.S., Congress de Varna, 1968.

GENERAL REPORT

INTRODUCTION

A Congress on Integration of Science Teaching organised by C.I.E.S. (Commissions Interunions de l'Enseignement des Sciences) was held in Varna (Bulgaria), at the Maison Internationale Joliot-Curie, from 11 to 19 September, 1968, by kind invitation of the Union of Scientific Workers of Bulgaria.

The Congress was initiated and financed, in part, by I.C.S.U. (International Council of Scientific Unions) and received financial support from UNESCO, the Ford Foundation and other national agencies responsible for the expenses of some of the participants.

The work in arranging a congress on this particular theme is particularly complicated and delicate and thanks are due to the organising

APPENDIX II
RESULTS OF QUESTIONNAIRE ANSWERED BY FIRST-YEAR MATHEMATICS STUDENTS, 1969

Macquarie University: 316 full-time DAY students (Answered at enrolment time).
Melbourne University: 548 students (Engineering students excluded).

	LOVE		LIKE		NEUTRAL*		DISLIKE		HATE	
	Macq.	Melb.	Macq.	Melb.	Macq.	Melb.	Macq.	Melb.	Macq.	Melb.
Mathematics	105 33.2%	117 21.4%	147 46.5%	313 57.2%	36 11.4%	75 13.5%	22 7.0%	35 6.4%	6 1.9%	8 1.5%
Physics	32 10.1%	67 12.4%	111 35.2%	245 44.7%	59 18.7%	134 24.3%	64 20.2%	62 11.3%	50 15.8%	40 7.3%
Chemistry	31 9.8%	57 10.4%	106 33.4%	298 54.5%	51 16.5%	111 20.2%	82 25.8%	57 10.3%	46 14.5%	25 4.6%
Biology	60 19.0%	63 11.5%	133 42.1%	188 34.4%	67 21.4%	238† 43.3%	40 12.6%	42 7.7%	16 4.9%	17 3.1%
Geology	35 11.0%	19 3.5%	93 29.4%	84 15.1%	104 33.1%	389† 71.1%	45 14.2%	38 7.0%	39 12.3%	18 3.3%
Geography	46 14.5%	16 2.9%	110 34.8%	61 11.1%	101 32.3%	383† 69.9%	37 11.4%	43 7.9%	22 7.0%	45 8.2%

* Neutral group includes those with blank responses.
† Note the large numbers in these groups.

Extra data obtained from original score sheets:	Macq.	Melb.
Love or like Mathematics and dislike or hate Physics	25.0%	13.0%
Love or like Mathematics and dislike or hate Chemistry	30.7%	13.5%
Love or like Mathematics and dislike or hate Physics or Chemistry	41.7%	24.2%

STATISTICAL SUMMARY

(Dislike or hate)/Total

	Macquarie	Melbourne	Difference	S.D. of Difference	Comment
Mathematics	0.0886	0.0785	0.0101	0.019	Not significant
Physics	0.3608	0.1861	0.1747	0.031	Highly significant
Chemistry	0.4051	0.1496	0.2555	0.030	Highly significant
Biology	0.1772	0.1076	0.0696	0.024	? significant
Geology	0.2659	0.1022	0.1637	0.026	Significant
Geography	0.1867	0.1606	0.0261	0.027	Not significant

(Dislike or hate + ½ neutral)/Total

	Macquarie	Melbourne	Difference	S.D. of Difference	Comment
Mathematics	0.1455	0.1460	—0.0005	0.025	Not significant
Physics	0.4525	0.3084	0.1441	0.034	Highly significant
Chemistry	0.4842	0.2500	0.2342	0.033	Highly significant
Biology	0.2816	0.3248	—0.0432	0.033	Not significant
Geology	0.4303	0.4561	—0.0258	0.035	Not significant
Geography	0.3449	0.5091	—0.1642	0.035	Highly significant

Comments

Mathematics. There is no significant difference in the numbers who are neutral or those who have a liking for or an aversion against Mathematics. There is an abnormal number who "love" rather than "like" Mathematics at Macquarie University.

Physics or Chemistry. A highly significant aversion against both of these subjects at Macquarie University.

Biology or Geology. No significant difference in the numbers who like or dislike these subjects but there is an abnormally low proportion of "neutral" students in the Macquarie Questionnaire.

Geography. A highly significant liking for Geography in the Macquarie Questionnaire as well as an abnormally low proportion of "neutral".

committee (Dr. H. Freudenthal and Dr. W. C. Kelly) and particularly to the secretary, Professor P. Fleury, and his assistant, Madame A. Vuillemin.

Fifty-six papers were submitted in advance and these were used to prepare a preliminary report. During the Congress 10 general sessions were held and seven study groups were established; the reports of these sessions and discussions form the basis of this report. A number of the actual reports will be found in the appendix.

The aims of the Congress were to study the possible development of courses in integrated science and to discuss the best way of organising the teaching of the subject as a coherent whole, particularly at the secondary level. Since the subject is so large the problem of integration of science with social science, psychology and economics has been omitted.

It is obviously necessary, in order to avoid ambiguity, to distinguish clearly between

a) complete *integration*, which consists of joining several subjects into a single course in which the concepts of science are presented through a unified approach.

b) *Coordination*, which entails a carefully planned collaboration between the various disciplines and in the training of teachers for such an approach.

1. COMPLETE INTEGRATION

1.1 *Contribution of integration to the teaching of Science*

The following considerations may be considered to justify the attempt to introduce integrated science courses:

a) Science teaching should contribute towards culture and general education, bringing to all pupils a suitable basis for citizenship and, where necessary, a preparation for university studies. Science education should be directed firstly towards scientific literacy and an understanding of scientific progress.

b) Programmes now in use in different countries present an impressive survey of all that could be taught. But a difficult choice of material has to be made.

c) From a variety of phenomena, fundamental principles of science can be derived (e.g., order-disorder, conservation of energy, etc) which find their application in the most diverse fields.

d) Emphasis is placed on the fundamental unity of science.

1.2 *Contribution of integration to pupils' activities*

Integrated science provides the opportunity of introducing pupils to solving problem situations. This develops his activity, his creativity, his independence; it is in this way that he acquires the right approach to methods of working. It also provides the opportunity of illustrating the essential historical development of the main scientific theories.

From the educational point of view, integration avoids unnecessary repetitions, thus saving an appreciable amount of time, emphasises analogies and gives importance to fundamental principles and methods.

1.3 *Content of an integrated course*

The course should emphasise to the pupils the importance of observation for increased understanding of the world about them; it should help them to appreciate the modes of thought and the ways of working, characteristic of science; it should develop their interest in science and its applications, and should bring to their attention some of the major problems facing mankind; it should also help them to recognise whether they have a particular apitude for scientific work.

There are many ways in which these aims might be achieved, and many different courses should be designed and tested.

The following example may give some idea of topics that could provide the beginnings of an integrated course; air, water, the earth, forests, domestic animals, farms, hygiene, food, time, movement, measurement, light, weather, energy, etc.

1.4 *Teaching methods*

Integrated science has as its essential aim the teaching of pupils to reason precisely and to react appropriately to given situations. Thus heuristic methods and other investigatory methods in which pupils participate personally as the course develops have to be widely used.

In order to bring out the fundamental principles one takes into account the maturity of the pupils. Although the child is much more able to understand abstractions than is generally realised it is always necessary to begin with specific examples and only to introduce generalisations that correspond with the degree of comprehension of the pupils.

Involving brief references to philosophy and history of science they can be helpful only on condition that they are not abused and are only utilised when the pupils have adequate knowledge and understanding of the subject matter.

1.5 *Implementation of Integration at the first stage of secondary education*

Whatever the interest in integration it must be implemented cautiously for there is always the risk of ending up with an approach that is disordered and superficial.

The extent of integration and the balance between complete integration and coordination will depend on the age of pupils (complete integration being easier with the junior classes), the type of educational establishment (ordinary school, technical school, etc) and local conditions (administrative structure and local traditions).

At the earlier stages of secondary education emphasis must be

placed on experimental aspects of science and a totally integrated course in natural science (physics, chemistry, biology, earth sciences, astronomy, etc) appears generally desirable. But it is useless for educationalists quickly to write a syllabus for a course and then to expect it to be taught successfully. A great deal more is required in the way of planning, testing and implementation—all rather lengthy and costly processes.

Implementation of educational reform leading to integrated science courses may include:

a) formation of working groups

b) definition of rationale, parameters, content and pedagogic style

c) study of relevant curriculum projects

d) seeking advice from experts in related fields

e) development and testing of learning materials

f) inauguration of teacher training programmes

g) dissemination of project information.

APPENDIX IV

SCIENCE COMMITTEE OF THE N.S.W. TEACHERS' FEDERATION
N.S.W. SCIENCE TEACHERS' ASSOCIATION
SENIOR SYLLABUS RECOMMENDATIONS

The following recommendations were agreed to at a joint meeting of representatives of the above two organisations on Wednesday, March 7, 1969.

1. Minor quantitative additions should be made to the present Level 3 science course which should then become examinable at the equivalent of Level 2. A separate part-time syllabus committee should be set up for this purpose.

2. Self-contained courses of 6 periods per week in *each* of the separate sciences—physics, chemistry, biology and geology—should be made available to schools for the beginning of 1970.
   Separate part-time syllabus committees should be set up for each course. The syllabus committee should first of all investigate courses being taught in other States and other countries and if any of these appear to be suitable they should be adopted on a trial basis. If none of the available courses in a particular discipline are considered suitable a full-time syllabus construction group should be set up to prepare a new course.
   The standard of these courses should be such that each would be acceptable as meeting assumed knowledge requirements for the corresponding A stream course in the first tertiary year.

3. A 12 period per week three-strand course should be prepared by a full-time syllabus construction group under the guidance of the Senior Science Syllabus Committee and introduced to schools on a trial basis at the beginning of 1970.
   The course should contain compulsory strands of physics and chemistry and provide for a choice of either biology or geology as the third strand.
   Approximately equal time allocation should be given to each strand. The standard of this course should be such that each *strand* would meet assumed knowledge requirements for the corresponding A stream course in the first tertiary year.
4. All future syllabuses should be accompanied by a statement of Aims and Objectives expressed in behavioural terms which determine the content of the syllabus in broad outline.
5. New courses should not be forced on schools. The older courses should remain in existence and available to schools who wish to continue with them until the new courses have been given a thorough trial. No new courses should be finally approved by the Board until it has been shown to be satisfactory by actual teaching experience in a cross-section of schools.
6. The development and trial of new courses should be fostered and encouraged as a continuous process. There should always be a few new courses under trial or gaining in popularity and a few others on the wane.

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